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141.

MEMOIRS OF THE GEOLOGICAL SURVEY.

ENGLAND AND WALES.

THE GEOLOGY OF THE COUNTRY BETWEEN DERBY, BURTON-ON-TRENT, ASHBY-DE-LA-ZOUCH AND LOUGHBOROUGH.

(Explanation of Sheet 141.)

BY
C. FOX-STRANGWAYS, F.G.S.

WITH
A Chapter on Charnwood Forest by Prof. W. W. Watts, M.A., M.Sc., F.R.S.

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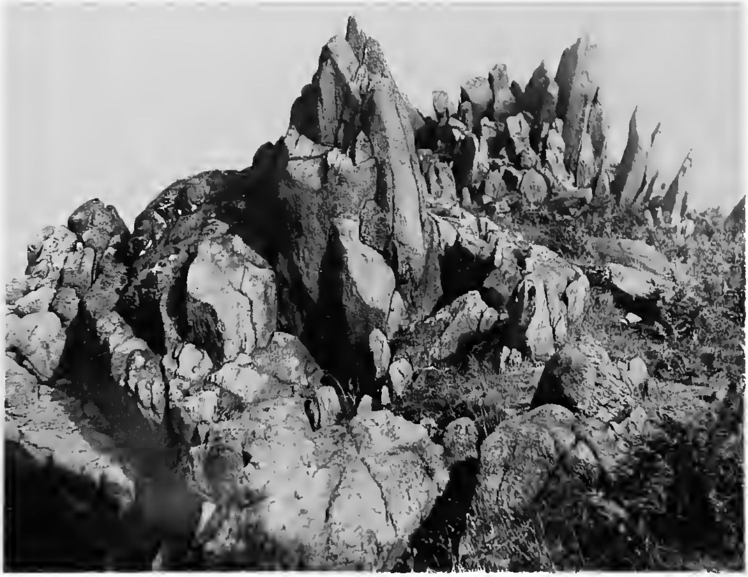

HIGH SHARPLEY, CHARNWOOD FOREST.

PREFACE.

The area described in the present Memoir (descriptive of Sheet 141 of the New Series one-inch map of England) contains parts of the north-west of Leicestershire, the south of Derbyshire and the south-west of Nottinghamshire, together with a small portion of the eastern side of Staffordshire. It includes most of the area represented in the quarter sheet 71 S.W. of the Old Series Geological Survey map, which was surveyed by Prof. Hull and published in 1855; the eastern edge of 72 S.E. surveyed by H. H. Howell and published in 1852; and the western part of 71 S.E. surveyed by Prof. Hull and published in 1855. A portion of the area was described in Prof. Hull's memoir issued in 1860 on the Geology of the Leicestershire Coal-field and the country around Ashby-de-la-Zouch; other tracts are referred to in the memoir on the Triassic and Permian Rocks of the Midland Counties of England by Prof. Hull, published in 1869.

A comparison of the New and Old Series maps shows that considerable changes have been made in the delineation of the geology of this part of the Midlands. The employment of the Ordnance maps on the scale of six inches to a mile has made it possible to introduce more detail and to ensure greater accuracy than was attainable with the smaller scale. Another cause of the difference in the mapping is the recognition of the fact that the most important faults in the district are of pre-Triassic age and that when, as in the case of the great Boothorpe fault, west of Blackfordby, they affect the Trias, the movement in the latter rocks is much less than in the underlying Coal-measures.

The drifts have been surveyed for the first time. They are far less important in this district than in the areas to the south and east, the Glacial period being represented only by thin scattered deposits, principally capping a portion of the higher ground.

Considerable difference occurs in the mapping of the alluvium partly from the lines having been traced with greater accuracy and partly from the older grovels and river terraces being now separated from one another. Mr. Deeley was the first to point out the difference in age of these deposits, which is very marked in the valley of the Trent and its larger tributaries. As stated in the explanation of Sheet 155, there is considerable doubt as to the age of the breccia mapped as Permian. This breccia may eventually be classed with the Trias, but at present it is more convenient to retain the name Permian.

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The district has been surveyed by Mr. Fox-Strangways, except the small area forming the northern end of Charnwood Forest, which has been mapped by Prof. Watts. The memoir has been prepared by Mr. Fox-Strangways, Prof. Watts supplying a concise account of the pre-Cambrian rocks of Charnwood Forest.

Six-inch maps of the Leicestershire Coal-field will be published, and MS. copies of other six-inch maps have been deposited in the office for reference. The Drift edition only of the one-inch map is colour-printed.

We are especially indebted to Mr. Horace T. Brown, who has placed at our disposal much information which he personally obtained on the northern borders of the area.

A bibliography of Leicestershire geology was printed in the Memoir on the geology of the country between Atherstone and Charnwood Forest.

J. J. H. TEALL,
Director.

Geological Survey Office,
28, Jermyn Street, London.
24th January, 1905.

CONTENTS.

Page

PREFACE by the DIRECTOR iii

CHAPTER I. INTRODUCTION. *General description of the district, Physiography, Classification, and Table of Strata, Soil, Economic Products and Water Supply* - 1

CHAPTER II. PRE-CAMBRIAN. *The Rocks of Charnwood Forest* 5

CHAPTER III. CARBONIFEROUS. *Carboniferous Limestone, Millstone Grit, Coal-measures* 13

CHAPTER IV. PERMIAN. *Breccia and Purple Marls* 24

CHAPTER V. TRIAS. *Bunter Sandstone and Pebble Beds, Lower Keuper Sandstone and Marls, Keuper Marl ; Rhætic Beds* 30

CHAPTER VI. LIAS. *Lower Lias* 3

CHAPTER VII. PLEISTOCENE AND RECENT. *Glacial Deposits, Post Glacial Deposits, High Level Valley Gravel, River Terraces, Lacustrine Clay, Alluvium* 39

CHAPTER VIII. PHYSICAL STRUCTURE AND FAULTS. *Breedon Fault, Thringston Fault, Cole Orton Fault, Boothorpe Fault, Newhall Fault, Linton Fault, Normanton Hills Fault, Foremark Fault, Winshill Fault* 45

APPENDIX.—BORINGS AND PIT SECTIONS 49

INDEX - 79

LIST OF ILLUSTRATIONS.

Plate. HIGH SHARPLEY, CHARNWOOD FOREST.
Photograph by Mr. A. W. Searley *Frontispiece*

Page

Fig. 1. Blackbrook. An emptied Triassic fiord 11

„ 2. Limestone Quarry, Grace Dieu. Section showing cavities in the limestone filled with marl . 13

„ 3. 4. Castle Donington Gas Works. Sections showing unconformable junction of Trias and Carboniferous Rocks - 19

„ 5. Clay pit at Blackfordby. Section showing Permian resting on Coal-measures 27

„ 6. Section at Linton showing Permian faulted against Lower Keuper Sandstone 29

„ 7. Railway Cutting, Normanton Hills. Section showing Lower Lias faulted against Keuper Marl 37

THE GEOLOGY

OF THE COUNTRY BETWEEN

DERBY, BURTON-ON-TRENT, ASHBY-DE-LA-ZOUCH, and LOUGHBOROUGH.

CHAPTER I.

INTRODUCTION.

This sheet contains an area of 216 square miles, and includes portions of the four counties of Derby, Leicester, Nottingham, and Stafford. Rather more than half of this lies in the county of Derby, about a third in the county of Leicester, while about twenty-four square miles are in the county of Nottingham, and about two square miles in that of Stafford. It includes nearly the whole of the area shown in 71 S.W., together with the western portion of 71 S.E,, and extends somewhat further to the west and south than these maps.

Over the greater part of the area considerable more detail is shown than was possible on the former survey, both from the mapping of the Drift and post-Glacial beds, and from the more numerous subdivisions which, owing to the employment of larger scale maps, are able to be introduced. The principal of these alterations are the subdivisions of the Charnwood rocks, the revision of the Trias to the east of Burton, the addition of the Glacial beds, and the much greater development of the post-Glacial beds than was shown on the old maps.

The principal towns in the area are Derby, Burton-on-Trent, Ashby-de-la-Zouch, and Loughborough; besides which there are the populous districts around Swadlincote, Cole Orton, Swannington and Thringston in the coalfield; and Etwall, Eggington, Repton, Melbourne, Castle Donington, Long Eaton and many smaller villages along the valley of the Trent. There are also the important villages of Mickleover, Littleover, Borrowash, Draycott, Breaston, Sawley, Attenborough, Alvaston, Chellaston, Willington, Twyford, Barrow-on-Trent, Swarkeston, Weston-on-Trent, Aston-on-Trent, Shardlow, Newton Solney, Bretby, Ticknall, Breedon, Diseworth, Long Whatton, Hathern, Osgathorpe, Belton, Sheepshed, Kegworth, West Leake, Gotham, and many smaller places, so that the district as a whole is a fairly populous one.

The drainage of the district is entirely in the basin of the Trent, but although that river traverses its centre some of the small streams flow a considerable distance before they enter the main stream. Thus the little stream rising in the Pistern Hills, and flowing through Ashby, runs south to the Mease, and does not reach the Trent until it has traversed a distance of eighteen miles, although in the opposite direction its source is not more than five miles from this river. The principal tributaries of the Trent are the Soar, the Dove, the Derwent, and the Erewash, all of which join the main stream in this sheet. Thus the volume of the Trent becomes largely augmented within this area, and gives rise to the extensive alluvial deposits in the northern part of the map. The other streams are mostly very small, but some of them traversing old hollows have formed extensive lacustrine deposits as at Sinfin Moor, and to the east of Gotham. The main water-parting is the high ground formed by the Pistern Hills to the north of Ashby, and extending thence to Gresley and Linton. North of this all the drainage passes within the area of the map to the great central valley of the Trent; while on the south side the drainage first flows into the Mease and thence into the Trent. The most elevated part of the district is the high ground in the south-east formed by the northern end of the Charnwood Hills, which here rise to a height of about 700 feet, but a little further south attain an altitude of 912 feet above the sea. In the south-west part of the area the ground rises to over 500 feet along the Pistern Hills and at Swadlincote, and forms a sharp bluff above the Trent at Burton. The remaining area slopes gradually to the Trent valley, which declines from about 150 feet at Burton to not more than 80 feet in the north-east corner. Consequently the general aspect of the country is that of a broad valley running in a west and east direction.

The following formations occur in the area—

PLEISTOCENE AND RECENT	Recent and Post-Glacial	Alluvium. Lacustrine clay. River Terraces. High-level Valley Gravel.
	Glacial	Boulder-clay with beds of Sand and Gravel.
LIAS		Lower Lias.
TRIAS		Rhætic Beds.
	Keuper	Keuper Marl with thin Sandstones and bands of Gypsum. Lower Keuper Sandstone and Marls with occasional beds of breccia at the base.
	Bunter	Pebble Beds or Conglomerate and Sandstone.
PERMIAN		Breccias with red marl.
CARBONIFEROUS		Coal Measures. Millstone Grit. Carboniferous Limestone and Shale.
PRE-CAMBRIAN		Slates, hornstones, and agglomerates with intrusive igneous rocks.

The Trias, of which the Keuper Marl forms by far the larger portion, covers the greater part of the area, occupying nearly the whole of the lower ground and flanking the principal rivers on either side. The Coal-measures which occupy most of the remaining area are divisible into three portions, consisting of higher beds with coal seams at Swadlincote and Cole Orton on either side, and a lower or unproductive series between, extending from Ashby to Ticknall. North of this a small area of Millstone Grit comes up, extending as far as the Trent at Stanton. The other rocks that come to the surface are the isolated patches of the Charnwood rocks, which protrude through the marl in the south-east part of the map, and the inliers of Carboniferous Limestone and Shales which come up in the valleys at Ticknall, Calke, and Dimminsdale, or are thrown up by the fault between Breedon and Grace Dieu, forming a series of detached outcrops along that line. Besides these the only other formations that occur are the two small outliers of Lias and Rhætic beds at Gotham on the eastern edge of the map, and the narrow strip of Permian beds in the south-west quarter. There is very little Drift, and this is confined almost entirely to the Trias area, over which it has been extensively denuded, so that only patches remain on the relatively higher parts of the district.

The soil varies considerably in different places, being poor and cold over the Coal-measures and some of the other older rocks in the south; but much lighter and more friable over the Millstone Grit and about Melbourne, where it forms a sandy soil largely devoted to market gardening. The Keuper Marl on the whole forms good land, but its character is much altered in places by overlying Glacial beds; while the outcrop of the Bunter in the western part of the area gives rise to much light gravelly soil. The large spreads of alluvial gravel to the north of Burton and south-east of Derby also form much light land, but which, from their being deposited on clay, often require underdraining. The more modern alluvium of the larger rivers is of two periods, forming deposits at different levels, but these frequently merge into one another, so that no definite distinction can be made between them. As a rule, the higher part of this is gravelly and generally forms arable land; while the lower part which is either loam or clay is usually pasture.

The greater part of the district is devoted to agriculture, with the exception of the small area around Swadlincote, where coal and pottery clays are worked to a considerable extent. In fact, of late years the manufacture of sanitary pipes has become an important industry over this part of the coalfield. Most of the other towns and larger villages are also manufacturing centres on account of their proximity to the two coalfields of North and South Derbyshire.

The most important mineral of the district is the coal that is worked in several seams in the south-west corner about Stanton, Newhall, Swadlincote, and Gresley, and gives rise to the dense population around these villages.

The best building-stone is the Millstone Grit of Melbourne, Stanton-by-Bridge, and Dawson's Rocks; but it is very little used at the present time. Besides this the Lower Keuper Sandstone forms a soft and inferior stone, which was formerly worked on the east side of the Trent at Burton, at Bretby, and near Ashby, but the only quarry now in use is at the railway junction near Melbourne.

The igneous rock of the Charnwood series is worked at Newhurst near Sheepshed for roadstone, but the most extensive quarries in these rocks are a little further south.

The limestone inliers at Ticknall and elsewhere were formerly extensively worked, and burnt for lime, but now only the beds at Breedon and Breedon Cloud are being worked. A small quantity of lime has also been obtained from the Lias outliers north of Leake, but the beds are too thin to be of much value.

The Keuper Marl is worked for brickmaking at Burton, Derby, Loughborough, Hathern Station, and other places. Lead has been worked in the limestone near Calke, and manganese occurs in small quantities in the Keuper of Burton.

The chief water-bearing strata are the Millstone Grit, the Bunter Pebble Beds and the Lower Keuper Sandstone; but as none of these form very extensive outcrops in this district, their water-bearing capacity is not so great as is usually the case. The Millstone Grit probably forms the best source, and it has been utilised at Stanton for the supply of Melbourne, Castle Donington and Long Eaton*; while another boring in this rock at Milton supplies the populous district about Swadlincote. Loughborough obtains its water from catchment reservoirs in the Charnwood Hills.

---

* G. Hodgson, *Assoc. Municipal Eng.*, 1893.

CHAPTER II.

PRE-CAMBRIAN.

THE ROCKS OF CHARNWOOD FOREST

BY PROFESSOR W. W. WATTS.

Cropping up through the Triassic rocks in the south-eastern corner of this sheet, there are a number of inliers of ancient rock scattered over an area of about ten square miles. The most important of these are a group of summits ranging southward and westward from High Sharpley, and the mass of Ives Head near The Oaks, the highest points of which are over 600 feet above sea-level.

This area is the northern part of Charnwood Forest, and its rocks belong to the divisions already described in the Memoir on "The Country between Atherstone and Charnwood Forest."* The rocks comprise volcanic agglomerates, tuffs, and ashes, with grits, conglomerates, and slates; these are intruded upon by "porphyroids," syenites or granophyres, and a red felsite; and the whole of the rocks, with the doubtful exception of the last, are of pre-Cambrian age.

SUCCESSION.

The order and succession of the rocks can be better studied in the sheet to the south (155), the area from which the majority of the sub-divisions derive their names. The following table is an attempt to correlate together the principal divisions in different parts of the Forest:—

	Eastern Side	**Western Side**
C. The Brand Series	c. Swithland Slates	
	b. Conglomerate and Grit	
	a. Purple and Green Beds	
B. The Maplewell Series	e. Olive Hornstones of Bradgate	? The Porphyroids.
	d. Woodhouse Beds	
	c. Slate-Agglomerate	c. Slate Agglomerate of High Tors
	b. Beacon Hill Hornstones	b. The North-West Agglomerates
	a. Felsitic Agglomerate	a. The Abbey and Strawberry Hill Agglomerates
A. The Blackbrook Series		A. The Blackbrook Series

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* Explanation of Sheet 155. 1902.

SUB-DIVISIONS.

The Blackbrook Series.—The finest exposures and the greatest extent of this series in the Forest occur in this sheet. The winding course of the Blackbrook has cut twice through a band of massive conglomeratic grit, once below the new dam now being erected for the Loughborough Corporation, and again at Moult Hill, where the weathered rock is red in colour, but grey on a freshly cut surface. In both localities the rock has been quarried, and found to be of no great thickness, underlain and overlain by flinty, felsite-looking grits. It is probably the same band which is seen in a spinney south-east of Lubcloud Farm, shifted by one of the transverse faults. Locally other gritty bands occur in the series as at Ives Head and Fenney Hill, often containing pseudomorphs of pyrite cubes in hematite. The dominant rock, however, is a very fine-grained buff or greenish hornstone, probably a tuff, frequently well banded and deeply stained with red oxide along its joints. It dips usually at a high angle, and is much disturbed by the anticlinal and other faults.

The Maplewell Series.—This series occurs on the east side in its typical aspect, but on the western side it is only with difficulty recognisable for reasons to be presently stated.

The Felsitic Agglomerate.—A coarse agglomerate containing fragments of felsite and andesite is seen in Roe's Plantation north of Whittle Hill, and also in Longcliff Plantation. It is repeated by an overthrust fault in several plantations about a third of a mile to the eastward of Whittle Hill, and in some ground known as the Rough to the north. The basal bed of the great agglomerates of the north-west at Flat Hill, Kite Hill (Mount St. Bernard's Abbey), and Strawberry Hill Plantation appears to occupy the same position, and in litbological character presents certain similarities. This agglomerate, however, is coarser, and contains large bombs of andesite and dacite. Northward of the last point these rocks have not been recognised with certainty.

The Beacon Hill Hornstones and North-West Agglomerates.—These beds occur in a long strip running from Newhurst Plantation to Longcliff and on to Whittle Hill. The same rocks, repeated by the thrust mentioned above, are also seen running from Jamson's Plantation to Nanpantan, and hence through Buck Hills and the Outwoods. They are fine-grained, intensely hard and brittle, siliceous hornstones, or fine volcanic ashes of green or buff colour, often weathering white or cream-coloured, and colour-banded both on the weathered surface and in their interior. There are some well-marked grit bands, usually bearing epidote and quartz, in the sequence, one in particular being well exposed near Nanpantan and at the Buck Hills.

All the rocks visible in the north-west of the Forest from Whitwick to Grace Dieu, and from Thringston to Drybrook Wood, with few exceptions, are either porphyroids or coarse agglomerates. The latter show no bedding, and it is impossible to infer the succession, except from the fact that at Grace Dieu Warren in the north-east margin of this area, at Car Hill Quarry (near City of Three Waters) and at Forest Rock (Sheet 155) on its south-west margin, the dip is to the south-west. If this dip is maintained throughout, the succession would indicate that these agglomerates are later than the felsitic agglomerates in age, and probably older than the slate agglomerate, and hence that they are the equivalents of Beacon Hill hornstones. The agglomerates are very coarse, the bombs being frequently a foot and sometimes three or four feet in length. They consist mainly of compact or porphyritic "porphyroids," purple, pink, buff, or green in colour, generally sheared and cleaved, and at times flattened along the cleavage-planes. They can be seen in Drybrook Wood, Cademan Wood, near Hob's Hole, and at several places in Grace Dieu Wood.

At least two anomalous rocks occur in this area: The green hornstones based on an agglomerate bearing slate fragments at Grace Dieu Warren, and the remarkable coarse conglomerate or agglomerate, very much crushed and cleaved, which occurs in the Pinfold Quarries in Whitwick village, where the fragments consist mainly of a buff, sheared, non-porphyritic "porphyroid." No rocks on a higher horizon than this are known in the north-west area.

The Slate Agglomerate.—Rocks belonging to this division are readily recognised in a spinney a quarter of a mile south by west of Loughborough Parks Farm, and from this point can be followed at intervals through the Outwoods to the south-east, overlain and underlain by hornstones. Although thinner than usual, this rock is like that traceable round the Forest from Hanging Rocks through Bradgate Park to High Tors (Warren Hills West). It is an andesitic tuff bearing large and small fragments of purple and green slate.

The Brand Series.—This division is only seen at Forest Gate and in Burleigh Wood to the north of it. The usual divisions are present and are quite recognisable—bands of conglomerate interleaved with slate, a thin band of grit passing into quartzite, a dark plum-coloured grit rough to the touch; and, although no exposure was found in Burleigh Wood, the numerous fragments are of a slate closely akin to that of Swithland.

STRUCTURE.

The anticlinal form of the Forest Rocks is continuous from Sheet 155 into Sheet 141, but it widens out so that the Blackbrook beds occupy a maximum width of a mile and a half.

This is due to a south-east pitch of the axis, or else the fold-form is a semi-dome. Overthrust faulting, along N.W.-S.E. lines, appears to be also continuous from the sheet to the south, for the main overthrust brings up a strip of Blackbrook beds, running south-east from Longcliff Cottage to Beacon Cottage (Sheet 155), overlain by Maplewell beds, and apparently underlain by them. Several minor overthrusts are also visible, many of which contain small intrusions of syenite, while a long strip of syenite occupies the main overthrust from Longcliff Plantation to Newhurst Plantation near Sheepshed. It is highly probable, also, that there is a normal fault in the Upper Maplewell Beds as in the south, but of this there is only indirect evidence. The main anticlinal fault, and some of its branches, are also traceable in the north-eastern flank of Ives Head. The faulting of the north-west area cannot be traced, owing to the circumstances already pointed out, but there are numerous difficulties only explainable by faulting. It has not been possible as yet to locate these faults.

At least three important transverse faults traverse the area of Forest rocks in Sheet 141, belonging to the N.E.-S.W. set. The great Bardon Hill fault enters the map about west-south-west of Longcliff Farm, and runs through Nanpantan Reservoir and Loughborough Parks Farm. A second skirts Mount St. Bernard's Abbey on the south-east, and after passing Blackbrook Cottage, runs out near Sheepshed station. A third, passing the south-east flank of Peldar Tor (155), runs between Drybrook Wood and the Abbey, and passes out through Fenney Spring and the west side of White Horse Wood.

THE INTRUSIVE ROCKS.

These fall into three classes. First the "porphyroids" approximately contemporaneous with the great agglomerates; secondly, the "syenites" or granophyres associated with the N.W.-S.E. faulting; and thirdly a red micaceous felsite of unascertained relations.

The "Porphyroids." These rocks will be described in detail in the forthcoming memoir on Charnwood Forest and only a brief notice will be given here with a reference to the petrological work of Messrs. Bonney and Hill.* There are two principal types in Sheet 141.

The Porphyritic Type. This type is well seen in Peldar Tor Ratchet Hill, High Sharpley, Cademan Wood, Swannymote Rock, a spinney a little less than a quarter of a mile south-west of Grace Dieu Warren, on the railway north-west of Whitwick station, and on the same railway west of Grace Dieu Wood. The rock is a dacite, purple, lavender, or green in colour, with large porphyritic quartz, porphyritic orthoclase and plagioclase, together with some

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**Quart. Journ. Geol. Soc.*, vol. xxxiv., 1878, p. 199. *Id.*, vol. xxxvi., 1880, p. 337. *Id.*, vol. xlvii., 1891, p. 78.

ferro-magnesian mineral replaced by epidote, in a fine grained minutely crystalline to crypto-crystalline ground-mass usually containing much epidote and chlorite mingled with small felspar needles. No glass is found in the ground-mass, nor are there the textures usually seen in fine grained igneous rocks. The rock is generally cleaved and sometimes it is much crushed, and even passes locally into an augen-schist with "eyes" of quartz. It frequently contains fine-grained and basic knots and inclusions, and these are often compressed into eye-shaped patches surrounded by ground-mass so much sheared that the rock may easily be mistaken for a cleaved agglomerate. This is especially the case at High Sharpley, which also shows the "oyster shell" cleavage of the rock as a whole. (See Plate).

None of the junctions of this rock give conclusive evidence of its intrusive character, and Messrs. Bonney and Hill prefer to consider it as a series of lava-flows.* The writer, however, finds it impossible to account for the irregular outlines of the main mass except on the theory that it is intrusive, and it would be especially difficult to explain the isolated mass just north of High Sharpley on any other hypothesis. A mass of porphyroid has also been recently exposed in the Blackbrook, in excavating the trench for the Loughborough Corporation Reservoir, and this mass is unquestionably intrusive into the Blackbrook rocks, which are considerably hardened and altered at the junction. In Bardon Hill also, a similar "porphyroid" is found to be intrusive.

The Compact or Grimley Type. This type is not conspicuously porphyritic; it is compact, usually highly sheared, buff in colour, and apparently trachytic or andesitic in composition. Under the microscope it shows porphyritic orthoclase and plagioclase felspars but little quartz, in a very compact ground-mass. It is found on Temple Hill, at Grimley's Rock, and Broad Hill, all near to the City of Three Waters; a second patch occurs at Hob's Hole and the north-east corner of Grace Dieu Wood.

This rock may be a lava, but the general run of its outcrop in relation to what is supposed to be the strike of this district renders it more probable that it is intrusive. A somewhat similar "porphyroid" occurs at Charnwood Forest Farm on Sheet 155.

The Syenites.—Hitherto these rocks have not been discovered in the north-west area. A long strip runs from the De Lisle Arms near Sheepshed Station, through Newhurst Plantation, Ingleberry Rock, and Longcliff Plantation, along the great overthrust fault. The junctions with the Blackbrook beds are well exposed in the Newhurst Quarry (Charnwood Granite Co.), where the sediments are hardened but not much further altered.

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* *Quart. Journ. Geol. Soc.*, vol. xlvii., 1891, p. 82.

Numerous patches of a rock related to the last, but rather more basic in composition and much decomposed, are seen about the Rough, Buck Hill, and near the Convalescent Home. These are also associated with overthrust faulting. These rocks are described under the head of the "Northern Syenites" by Messrs. Bonney and Hill.* They contain augite and hornblende associated with orthoclase and plagioclase felspars, and generally show a micropegmatite of felspar and quartz.

The Felsite.—A dyke of a finely crystalline red rock with conspicuous mica flakes occurs on Ives Head, and runs in a straight line through the two plantations one-sixth of a mile north-east and east respectively of Lubcloud Farm. This is a porphyritic felsite with a compact ground-mass and phenocrysts of orthoclase, plagioclase, and mica, but no quartz. It does not appear to be related to any other rocks known in the Forest.

RELATIONSHIPS AND AGE.

It was remarked by Messrs. Bonney and Hill† that the coarsest agglomerates in the Forest are grouped around the "porphyroid" masses of Peldar Tor and High Sharpley, an observation fully confirmed by the writer. Further, these agglomerates almost invariably contain fragments, the bulk of which can be referred to known varieties of the porphyritic or compact types of porphyroids. Hence it is probable that this agglomerate group of the north-west represents the volcanic material deposited immediately round the volcanic vent, which became filled up with dykes, sheets, and bosses of quite similar porphyroids intruded in the later stages of the eruptions. This hypothesis would trace the volcanic material of the Maplewell Series to its source in a north-western vent, part of which is comprised within the area from Grace Dieu to Bardon Hill. It would also explain the occasional occurrence of masses of less coarse agglomerate (felsitic and slate agglomerate) all round the Forest, while the principal material deposited at a distance from the vent would be fine dust, ashes, and tuff, all of which are found to grow gradually coarser so far as they can be traced towards the north-western area. This is the justification for the correlation inserted earlier in this chapter.

The cleavage, shearing, and occasional schistosity of the "porphyroids" makes it quite certain that these rocks were in place before the folding and faulting of the rocks with which they are associated, as they have received precisely the same structures as the pyroclastic rocks themselves. The syenites, on the other hand, are not cleaved or sheared, while they have come up along the faults of the N.W.—S.E. system, and hence came into place in the later stages of the first earth-movement in the area.

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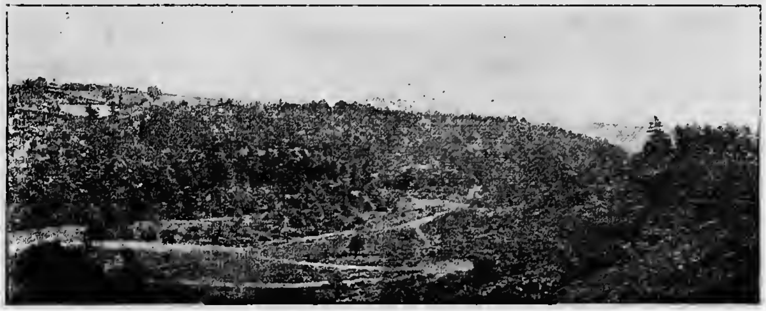
* *Quart. Journ. Geol. Soc.*, vol. xxxiv., 1878, p. 217.

† *Quart. Journ. Geol. Soc.*, vol. xlvii., 1891, p. 84.

Evidence as to the age of the rocks has already been given in the memoir in Sheet 155. The only rocks in contact with the Forest rocks are the Carboniferous and the Trias, both unconformable. These rocks must be of pre-Cambrian age, and for the present it is better to speak of them simply as belonging to *the Charnian System*, a system which it will probably be found possible to eventually correlate with the lower part of the Longmynd sequence of Shropshire.

The unconformity of Carboniferous and Trias makes it practically certain that Charnwood was a mountain area in Carboniferous and Triassic times, with steep slopes receiving the finishing touches of their denudation on the borders of the seas, deserts, and lakes of these periods. Modern denudation has done little to the hard rocks, and has been mainly occupied in clearing the Triassic sandstones and marls from the mountain flanks and valley sides, re-developing at the present day the Triassic landscape in much the same form as it had when buried up.* The denudation effected by the Blackbrook is of especial interest, as that valley has been practically scoured out, and displays to us the sole example in this region of a Triassic fiord, with much the same steep and rocky sides as it must have possessed when filled with the lake waters of the Trias. (See Fig. 1.)

Fig 1.. *Blackbrook. An emptied Triassic fiord.* (1)



ECONOMICS.

There is not much extensive quarrying now going on within the area comprised in Sheet 141. There are small quarries in the agglomerates and porphyroids of Whitwick, Grace Dieu, etc., and a rather larger one near High Sharpley. The Blackbrook beds are quarried at Fenney Hill, and a good deal of stone has been taken out along the Blackbrook. Large quarries have been opened by the Charnwood Granite Company at Newhurst

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* *Geogr. Journ.*, xxi., 1903, p. 623.

(1.) This illustration has been reproduced by permission of the Royal Geographical Society, from Prof. Watts's paper, "Charnwood Forest: A Buried Triassic Landscape." (*Geogr. Journ.*, June, 1903, Fig. 11 p. 10.)

Plantation, near Sheepshed, and about Longcliff, in the syenite, and a road metal with very high crushing strength has been obtained.

A reservoir has been formed in the Wood Brook at Nanpantan for Loughborough, and the same Corporation is at present engaged in building a high dam to impound the wasted flood waters brought down from the large drainage area of the Blackbrook. A grit band crossing the stream near the Hermitage has narrowed the valley considerably, so that a large reservoir area is commanded by a narrow dam, while the grit band itself furnishes much of the material for building the embankment. The site is almost identical with that originally crossed by the dam for the short-lived Charnwood Forest Canal reservoir.

W. W. W.

CHAPTER III.

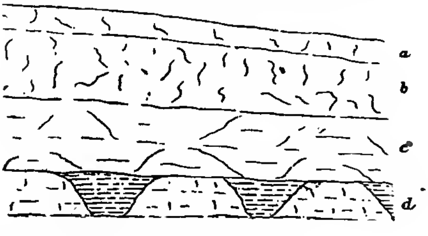
CARBONIFEROUS.

Carboniferous Limestone.

The Carboniferous Limestone is brought up by the continuation northwards of the Charnian axis, and crops out along two parallel lines striking in a N.W. direction. Along one of these the limestone comes up at Ticknall, Calke, and Dimminsdale in a series of inliers that have been exposed by streams traversing this line of elevation; while along the other at Breedon, Breedon Cloud, Barrow Hill, Osgathorpe, and Grace Dieu it is brought up by a line of fault.

The limestone has been worked at all the places where it is exposed, but the only quarries now in work are those at Breedon and Breedon Cloud. It is a magnesian limestone or dolomite, and consists of a light-coloured, brownish-grey, semi-crystalline rock, which is very hard and full of joints. At the south end, in the neighbourhood of the Charnwood rocks, the limestone is browner and more impure, and contains a line of cavities that are filled with a curious white sandstone or indurated marl as shown in the accompanying sketch.

Fig. 2.—*Limestone Quarry, Grace Dieu. Showing cavities in the limestone filled with marl.*



	Ft.	in.
a. Flaggy and lumpy-bedded limestone	3	0
b. Broken concretionary limestone	5	0
c. More or less bedded limestone - - - - -	5	0
d. Hard limestone with cavities filled with marly clay at least 2 feet deep, but base not visible, covered by talus.		

About 20 feet of limestone with shaly bands above *a*.
Dip 10° to 12° to N.W.

On the west side the beds bend over in a flat arch, but are fairly even and undisturbed. On the east side great disturbance has taken place especially at Breedon and Breedon Cloud, where the limestone is thrown nearly on end, and much broken up and shattered.

At Ticknall the limestone is very fossiliferous, but the working of the quarries having been abandoned for many years there is not now that facility for collecting that was formerly the case. A list of fossils from these localities is given in the old Memoir, but as most of the specimens were in private collections the species cannot now be verified, and therefore it has been considered more advisable not to reproduce this list.

Fortunately a large collection of the fossils from the Carboniferous Limestone of Ticknall and Breedon has of late years been made by the scholars of Repton School under the guidance of Mr. H. Vassall. These Mr. Vassall has kindly placed at our disposal for identification by Dr. F. L. Kitchin. The following table is drawn up from this list, supplemented by a few species from other collections.

*CARBONIFEROUS LIMESTONE FOSSILS FROM SOUTH DERBYSHIRE.**

	Ticknall.	Breedon.	Breedon Cloud.
CŒLENTERATA.			
Alveolites septosa, *Flem.*	R,S		
,, sp. -			R
Campophyllum cylindricum, *Scouler* (Zaphrentis, *Auct.*)	R		R,S ?
Clisiophyllum coniseptum, *Edw. & Haime*	R		
,, turbinatum, *M'Coy* (Dibunophyllum ?)	R,S		
,, sp. -	R		
Cyathophyllum Archiaci, *Edw. & Haime*	S		
,, sp.	R		R ?
Dibunophyllum ?	R		
Favosites parasitica, *Phil.*	R		
Lithostrotion irregulare, *Phil.*	S		R
,, junceum, *Flem.*	R,S		
,, sp.			S
Lonsdaleia floriformis, *Mart.* -	S		
Monticulipora tumida, *Phil.*	S		
Zaphrentis Enniskilleni, *Edw. & Haime*	R		
,, Phillipsi ? *Edw. & Haime* -	R		
,, sp. - -	R,S		
ECHINODERMATA.			
(CRINOIDEA.)			
Actinocrinus polydactylus, *Mill.*	R		
Platycrinus (fragment of stem) -			R
Poteriocrinus (fragment of stem) -	R		
,, (stem ossicles)	S		R
Rhodocrinus ,, ,, - -	R,S ?		

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* The letters in the columns indicate the following lists or collections:—D—Davidson, Mon. Brit. Foss. Brach.; R—Repton School Museum; S—Geological Survey; W—A. S. Woodward, Catalogue of Foss., Fishes, Brit. Mus., Vol. i.

	Ticknall.	Breedon.	Breedon Cloud
ECHINODERMATA—cont.			
(ECHINOIDEA.)			
Archæocidaris Urei, *Flem.*	R,S		
,, sp. (spine)	R		R
ANNELIDA.			
Serpula sp.	R		
CRUSTACEA.			
Phillipsia sp.	R		
POLYZOA.			
Ceramopora megastoma, *M'Coy* (Diastopora)	R,S		
Fenestella sp.	R,S		R
Retepora sp.	R		
Rhabdomeson gracile, *Phil.*	R		
BRACHIOPODA.			
Athyris ambigua, *Sow.*	R,S		R ?
,, expansa, *Phil.*			R
,, Roissyi, *Lév.*	R		
Chonetes laguessiana, *de Kon.*	R,S		
Cyrtina ? carbonaria, *M'Coy*			R
Cyrtina septosa, *Phil.*			R,S ?
Dielasma hastata ? *J. de C. Sow.*			R
Discina cf. Craigi, *Dav.*			R
Orthis Michelini, *Lév.*	R		
,, resupinata, *Mart.*	R		
Orthotetes crenistria, *Phil.*	R		R,S
Productus cora, *d'Orb.*			R
,, giganteus, *Mart.*	R,S		R
,, humerosus, *Sow.*		R,S,D	*
,, longispinus, *Sow.*	R		
,, plicatilis, *J. de C. Sow.*			R
,, punctatus, *Mart.*			R
,, pustulosus, *Phil.*			R
,, scabriculus, *Mart.*	R		
,, semireticulatus, *Mart.*	R,S		R
,, spinulosus, *Sow.*	R		
,, striatus, *Fisch.*			R
,, sp.		S	S
Rhynchonella acuminata, *Mart.*			R
,, pleurodon, *Phil.*	R		R,S
,, pugnus, *Mart.*			R,S ?
Spirifera crassa, *de Kon.*			R
,, duplicicosta, *Phil.*	R		R
,, glabra, *Mart.*	R,S		R
,, integricosta, *Phil.*	R		

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* Mr. A. R. Horwood has obtained this species from the new part of the Breedon Cloud Quarries known as "Klondike."

	Ticknall.	Breedon.	Breedon Cloud.
BRACHIOPODA—cont.			
Spirifera lineata, *Mart.*	R,S		R
,, ovalis ? *Phil.*			S
,, striata, *Mart.*	R		R
,, trigonalis, *Mart.*	S		R,S
,, ,, var. bisulcata, *J. de C. Sow.*	R		R ?
Strophomena rhomboidalis, *Wilck.*, var analoga, *Phil.*			R,S
Syringothyris cuspidata, *Mart.*		D	
LAMELLIBRANCHIATA.			
Allorisma sulcata, *Flem.*	R		
Aviculopecten plicatus ? *J. de C. Sow.*			R
Cardiomorpha Egertoni, *M'Coy*			R
,, orbicularis, *M'Coy*			S
Conocardium sp.	R		
Edmondia rudis, *M'Coy*			R
,, sulcata, *Phil.*			R
Leiopteria sp.			R
Parallelodon cancellatus ? *Mart.*			R
,, fallax ? *de Kon.*			S
,, haimeanus, *de Kon.*			R
Pinna flabelliformis ? *Mart.*			R
Protoschizodus æquilateralis, *M'Coy*			R
Pseudamusium ellipticum, *Phil.*			R
GASTEROPODA.			
Bellerophon sp.	R		R,S
Euomphalus pentangulatus, *Sow.*	R		
,, tabulatus, *J. de C. Sow.*			R
Macrochilina sp.			R
Naticopsis sp.	R		R
Platyschisma glabrata, *Phil.*			R
,, helicoides, *J. de C. Sow.*			R
Pleurotomaria rotundata, *J. de C. Sow.*			S
,, sp.			R
Turbonitella biserialis, *Phil.*			R
PTEROPODA.			
Conularia sp.			R
CEPHALOPODA.			
Artinoceras Sowerbyi, *M'Coy*			R
Cyrtoceras Gesneri, *Mart.*			R
Glyphioceras crenistria, *Phil.*	R		
,, sphæricum, *Mart.*			R
Nautilus sp.			R
Orthoceras sp.			R
Stroboceras sulcatum, *J. de C. Sow.*			R

	Ticknall.	Breedon.	Breedon Cloud.
PISCES.			
Cladodus mirabilis, *Ag.*	W		
,, striatus, *Ag.*	S,W		
Copodus prototypus, *Davis*	R		
,, spatulatus, *Davis*	W		
Ctenoptychius lobatus, *Eth. jun.*	R,W		
,, serratus, *Owen*	R		
Cyrtonodus Hornei, *A. S. Woodw.*	W		
Deltoptychius acutus, *M'Coy*	W		
,, gibberulus, *Davis*	W		
,, ?	R		
Janassa imbricata, *M'Coy*	W		
Megalichthys ?	R		
Orodus moniliformis, *Davis*	S		
Petalodus acuminatus, *Ag.*	R,S,W		
Petalorhynchus psittacinus, *M'Coy*	W		
Pleuroplax Woodi, *Davis*	S,W		
Pœcilodus Jonesi, *M'Coy*	S W		
,, sp.	R		
Pristodus Benniei, *Eth. jun.*	W		
Psammodus rugosus, *Ag.*	R		
Psephodus magnus, *M'Coy*	R,W		
Xystrodus striatus, *M'Coy*	R,S,W		

In addition to the above the following, which are in the Leicester Museum, are recorded from Dimminsdale.

Poteriocrinus (stem fragments).
Phillipsia sp.
Othotetes crenistria, *Phil.*

The limestone of Ticknall is also very rich in Foraminifera. A large number of species from here are enumerated by E. Wilson, Midl. Nat. 1880, p. 221.

At Breedon Cloud the limestone that occurs in layers is said to make the best lime for agricultural purposes, while the more irregular rock, "knob-stone," is best for building. There are many decomposed fossils here, but they are rarely found well preserved. There are no mineral ores in this quarry, but galena was formerly worked at Dimminsdale, and copper ore is said to have been obtained in Calke Park. The following analysis was made in 1882 by Mr. R. B. Barratt :—

Analysis of lime made from the Dolomitic Limestone of Breedon Cloud.

Caustic lime	53·4
Magnesia	21·5
Carbonate of lime	7·3
Carbonate of magnesia	10·1
Alumina	3·1
Ferric oxide	2·2
Moisture	2·4
	100·0

LIMESTONE SHALES.

Above the limestone there are a series of dark shales with thin beds of sandstone and limestone, becoming more sandy and ferruginous in the upper part. These shales are well exposed at Ticknall and Dimminsdale; they vary considerably in thickness, but at the latter place are from 30 to 40 feet thick. They are also seen at Calke, under the railway at Worthington, and at Grace Dieu,* but at Breedon, Barrow Hill and Osgathorpe are hidden by the overlap of the Trias.

At Kings Newton these shales are brought up against the fault, and are seen in the brickyard alongside the railway, where they contain thin bands of limestone and some pyrites. The beds here are turned sharply up, and dip to the W. at an angle of 45 degrees.

Their outcrop, however, is not so extensive as shown on the old map, especially around Ticknall, where Permian and Triassic marls have been included in these shales. Both the limestone and shales are thinning out in this neighbourhood, and from attaining a thickness of 5,000 feet in Derbyshire are not more than 500 feet at Breedon†, and probably much less than this on the flanks of Charnwood. The shales also have decreased from about 2,000 feet in North Derbyshire and Staffordshire to 50 feet or less in this district.

MILLSTONE GRIT.

At the northern end of the coalfield a series of massive grits comes out at Dawson's Rocks, which have been deeply cut into by the small stream running towards Milton.‡ The beds are overlapped on the higher ground by the Trias, so that their relation to the Coal-measures is not very clear, and it is possible that the division between them should be taken at a slightly higher horizon than is shown on the map. This would include some of the beds that crop out between here and Staunton Harold; which, on account of their general shaly character, have been correlated with the Coal-measures, but might equally well be classed with the Millstone Grit, there being in this district no very definite line between these two subdivisions.

At Ticknall the outcrop is broken by the northern end of the great Thringston Fault, but as this fault is dying out in this direction the displacement here is probably not very much.

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* Coleman states that there were from 10 to 12 yards of shale found in the well at the Lodge close by the quarry.

† This thickness is calculated on the supposition that there is not much limestone hidden by the Trias.

‡ It is probable that the Millstone Grit occurs almost immediately below the valley all the way to Milton; Dr. Horace T. Brown informs us that there is a floor of this rock a short distance below the surface at the latter place, the beds having a strong inclination to the N., but very uneven and eroded.

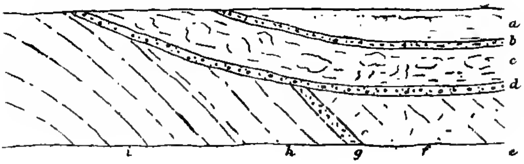
The general effect of the fault, however, is to terminate the coal-field, and bring in a considerable area of Millstone Grit rocks, which extend east as far as Melbourne, and north to the Trent valley.

A small inlier of these rocks is exposed to the north of Thringston, where they crop up in the valley just beyond the fault. The beds consist of coarse massive grits with some shale, but there is not sufficient exposure to be able to state to what part of the series they belong. They are brought against the Coal-measures to the south by the great N.W. fault, and the outcrop is obscured in other directions by the overlap of the Trias.

At the base of the hill on the north side of Castle Donington some loose grits crop out along the lane; and at the Gas Works, some shales with thin sandstones were found which are of Carboniferous age, but it is doubtful to which division they should be assigned. They were exposed in making a circular excavation 61 feet in diameter for a gas-holder in 1884, and were noted by Dr. Horace Brown, to whom we are indebted for the following sketch and particulars:—

FIG. 3.—*Section showing unconformable junction of Trias and Carboniferous rocks, Castle Donington Gas Works.*

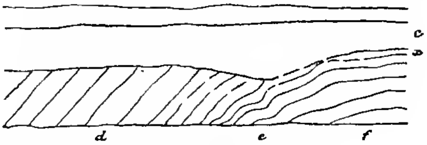
(*From a sketch by Dr. Horace T. Brown.*)



	Ft.	in.
a. Mottled red marl. There are 30 to 35 feet of this between the top of the section and the pseudo-basement beds higher up the escarpment. There is a band of brecciated Carboniferous rocks just at the base of the escarpment, and a few feet above the section.		
b. Breccia (fragments of Carboniferous grits) - -	1	6
c. Soft red sandstone and marl with light coloured blotches	5	6
d. Thin layer of subangular quartz pebbles.		
e. White and red mottled clays.		
f. Purple marls with a few thin beds of ironstone	6	6
g. Hard purple sandstone - -	1	0
h. Laminated purple and grey mottled shales with thin bands of grit - -	6	6
i. Dark laminated sandy clays.		

Dip of Keuper 14° S. 20° W.; Carboniferous, 34° S. 50° W. to 45° nearly W. with symptoms of disturbance on the N.W. side.

FIG 4.—*Castle Donington Gas Works. Section looking N.W. on the opposite side of the excavation.*
(*From a sketch by Dr. Horace T. Brown.*)



c. Red and mottled marls and sandstone.
d. Purple and white clays, contorted.
e Purple and mottled clays, in part contorted.
f. Dark clay.
x Shows a terrace in Carboniferous strata.

The edges of the Carboniferous strata are disturbed, and dip 45° on this side.*

Mr. Coleman mentions a small inlier of Millstone Grit at Wilson.† We were not able to find the rock at this place, but it is very possible that it is turned up here against the fault in the same manner as the Limestone is at Breedon, and the Limestone Shale at Kings Newton.

The Millstone Grit has been separated into three divisions—an upper series of fine-grained, thin-bedded sandstones; a middle series of massive coarse, yellow, brown, and red grits; and a lower series of coarse conglomeratic beds; but these divisions are not very distinctive, and their character does not appear to be persistent. In a general way the beds may be said to be coarser in the lower part, and softer and finer in the upper part.

Although the several thick beds of grit form distinctive features along their north-west margin, it has not been found possible to trace them for any distance, and no definite sequence can be made out. They probably have a thickness of 200 or 300 feet, and consist in the lower part of coarse massive grit with large quartz fragments and pebbles separated by bands of shale. Higher up the beds are finer grained, and have been worked for building-stone at Dawson's Rocks, Stanton, and Melbourne. The higher beds are much softer and more loamy; so that, in many cases, it is difficult to distinguish them from either the overlying Coal-measures or Keuper sandstones. Thus a large area at Foremark Park Farm was shown on the old map as Millstone Grit, although there is not much doubt that that rock is entirely buried beneath the Trias. The beds dip mostly to the N.E., but they probably turn up again on their eastern edge, and dip to the S.W., forming a syncline between the Limestone outcrops that strike through Ticknall and Breedon. At Castle Donington these rocks also dip to the S.W., but there are no other sections to show how far this dip extends.

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* Mr. Shipman gives a rather different drawing of this section. He considers the underlying strata to be Coal-measures, but gives no evidence for that supposition (*Trans. Notts. Nat. Hist. Soc.* 1886, pp. 61-65).

† White's History of Leicester and Rutland, p. 86.

From the soft sandy character of the upper part of this formation it forms good arable land; which, in the neighbourhood of Melbourne, is largely appropriated for market gardens. The water supply afforded by these rocks is good, and is utilised for the supply of Melbourne, Castle Donington, Long Eaton and other places along the Trent Valley, as well as Swadlincote and other places in the coalfield. Wells have been sunk for this purpose at Stanton and at Milton, which yield a large supply of very good water.*

COAL MEASURES.

As it is intended to write a separate memoir on the coalfield, it will only be necessary to give here a very brief account of that area. The Coal-measures in a general way consist of an alternating series of sandstones and shales with many seams of coal on certain horizons, and some ironstones. The several divisions vary considerably in different places, as may be seen in the tables given below, or more fully in any collection of pit sections such as will be published in the forthcoming memoir.

These beds cover an area of over forty square miles in this map, and extend for some considerable distance into the map to the south. They form three distinct districts running parallel to each other in a N.W. and S.E. direction. The lowest measures which occupy the central portion have been called the unproductive series, from their containing no important coal seams. The strata over this portion form an anticlinal arch, the axis of which ranges in a N.W. and S.E. direction through the town of Ashby-de-la-Zouch, so that the beds on either side turn over to the N.E. and S.W. A few thin coal seams crop out in the higher part of this series, but are partly hidden by the overlap of the Keuper Sandstone forming the mass of the Pistern Hills and its branches.

On either side of this central part are the two productive coalfields; that on the west comprising the South Derbyshire and Moira Coalfield, while that on the east is known as the Cole Orton or eastern division of the coalfield.

The first of these, the western coalfield, is cut off from the unproductive measures by the great Boothorpe fault, which forms its eastern boundary. On the west the Coal-measures pass beneath the overlying Trias, and it has not yet been proved how far they extend in this direction; while to the north and south the measures turn up, and the various coal seams crop out in either direction. The deepest part of the coalfield is about Moira, close to the edge of the map. The following table gives the thickness of the coal seams and intervening measures in this part of the district.

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* A detailed account of these wells is given by Mr. Hodson in a paper read before the Association of Municipal Engineers, 1893.

Table showing the thickness of the coal seams and intervening measures in the northern portion of the Western Coalfield.

	Stanton Old Colliery.	Bretby Colliery.	Woodfield Colliery.	Hawfield Colliery.	White House Colliery.	Cadley Hill Colliery.	Granville Colliery.	Gresley Wood Colliery.	Reservoir Pit, Moira Colliery.	Netherseal Colliery.
Measures containing the Ell coal and many thin seams -										
Dickey Gobler Coal -	—	—	—	—	3·0	—	—	4·6	3· 6	—
Measures -	—	—	—	—	124·0	—	—	115·6	117· 4	—
Jack Dennis Coal -	—	—	—	—	4·0	—	—	4·0	2·10	—
Measures -	—	—	—	—	242·5	—	—	226·8	210·10	—
Little or Five Feet Coal - -	—	—	—	5· 0	5·0	6·2	—	6·2	4·6	
Measures -	—	—	—	172·10	140·6	186·2	—	177·1	163· 7	—
Main Coal: Over Coal -	6·0	—	—	5·10	5·0	7·0	2· 6	6·0	7· 6	—
Main Coal	60·0	—	60·0	1· 6	2·0	1·3	5· 0	·9		14·1
Main Coal: Nether Coal -	6·0	7· 9	9·0	9· 0	5·0	8·0	10· 6	9·0	7· 3	
Measures -	—	42· 0	—	43· 0	48·0	43·1	33· 0	—	20 10	27·7
Toad or Little Woodfield Coal - -	—	4·11	—	4· 0	4·0	5·4	3· 0	—	3· 4	2·0
Measures -	—	111· 9	219·0	144· 0	135·0	112·6	62· 0	—	95· 4	58·7
Slate Coal -	—						1· 8	—	3· 8	3·9
Measures -	—						61· 4	—	—	52·6
Woodfield Coal -	—	6· 1	6·0	6· 0	5·0	6·0	6· 0	—	—	5·1
Measures - -	—	64· 3	—	71· 6	75·0	64·5	31· 6	—	—	30·3
Stockings Coal - -	—	5· 2	—	7· 0	6·0	5·8	6· 0	—	—	6·3
Measures -	—	42· 2	—	76· 0	—	73·2	68· 6	—	—	40·4
Eureka Coal -	—	4· 8	—	5· 0	—	4·6	3·10	—	—	2·8
Measures -	—	90·11	—	—	—	73·6	64· 0	—	—	—
Stanhope Coal - -	—	4· 7	—	—	—	4·5	4· 6	—	—	—
Measures -	—	75·11	—	—	—	—	—	—	—	—
Well Coal -	—	2· 4	—	—	—		—	—	—	—
Measures -	—	214· 0	—	—	—	—	—	—	—	—
Kilburn Coal -	—	4· 6	—	—	—	—	—	—	—	—

The Cole Orton, or eastern portion of the coalfield is bounded on the N.E. by a large fault, ranging through Whitwick and Thringston, to the south of Staunton Harold, Calke, and Ticknall, which throws out the Coal-measures, and brings up lower beds beneath a covering of Triassic rocks. The Coal-measures dip to the east, and the various seams of coal crop out on the northern and western sides of the area; but are largely hidden by the overlap of Triassic rocks, which cover the greater part of the district. On the western side these beds are probably bounded by a small fault, but nevertheless rise fairly regularly above the unproductive measures. The deepest part of this coalfield is along its eastern edge, at Swannington and further south.

The following table gives the thickness of the coal seams and intervening measures in this part of the district. Considering that the eastern and western portions of this coalfield are only about five miles apart, it is very remarkable that the difference in the measures should be so considerable.

Table showing the thickness of the coal seams and intervening measures in the northern part of the Eastern Coalfield.

	Swannington Colliery Pumping Works.	Califat Pit (Alabama Pit), Cole Orton Old Colliery.	Peggs Green Colliery, Peartree Pit.	Willis Bayley's Pit, near the George Inn.	New Swannington Colliery, Sinope Pit.	Cole Orton Colliery.	Smoile Wood Pits.	Lount Pottery Works.
Measures with thin seams of Coal								
Stone Smut Rider	3·9	3·6	—	—	—	—	—	—
Measures	31·9	42·3	—	—	—	—	—	—
Stone Smut Coal	6·0	5·1	6·0	4·9	—	—	—	—
Measures	19·0	16·2	21·0	9·0	—	—	—	—
Swannington Coal	4·6	2·3	4·6	4·6	—	—	—	—
Measures	43·0	44·3	36·4	102·0	—	—	—	—
Soft and Three Quarters Coal	2·3	2·3	2·3		—	—	—	—
Measures	38·3	35·8	34·5		—	—	—	—
Slate Coal Rider	1·3	·9	1·0	1·0	—	—	—	—
Measures	16·6	12·10	14·6	15·0	—	—	—	—
Slate Coal	6·3	4·6	5·0	5·0	—	—	—	—
Measures	61·8	58·9	75·4	18·0	—	—	—	—
Yard Coal: Coal	4·4	2·3	3·0	2·0	—	—	—	—
Yard Coal: Bind		1·6	·0	1·0	—	—	—	—
Yard Coal: Coal		·8	1·0	3·0	—	—	—	—
Measures	80·1	85·11	81·10	112·6	—	—	—	—
Stinking Coal Rider	2·2		2·6		—	—	—	—
Measures	7·0		·6		—	—	—	—
Stinking Coal	4·3	3·6	4·0	6·0	—	—	—	—
Measures	63·2	65·0	55·0	55·6	—	—	—	—
Main Coal	7·5	6·6	6·6	6·0	4·9	5·0	—	—
Measures	6·9	—	—	—	51·10	14·6	—	—
Smoile Coal	4·2	—	—	—		3·4	3·9	—
Measures	34·6	—	—	—		—	44·3	—
Upper Lount Coal	1·6	—	—	—	1·2	—	3·0	3·0
Measures	41·2	—	—	—	40·3	—	37·6	30·10
Middle Lount Coal	5·8	—	—	—	4·6	—	4·6	4·0
Measures	39·9	—	—	—	17·9	—	25·6	33·0
Nether Lount Coal	6·0	—	—	—	3·6	—	4·6	4·0
Measures	24·0	—	—	—	—	—	—	24·3
Roaster Coal	3·3	—	—	—	—	—	—	2·10
Measures	69·11	—	—	—	—			—
Coal	3·4	—	—	—	—	—	—	—

CHAPTER IV.

PERMIAN.

There are some purple marls and breccia with a little sandstone found here and there between the Carboniferous and Triassic strata which have been considered to be of Permian age. There is, however, no decisive evidence to class them with that formation, and they may represent either a distinct period, or the commencement of that of the Trias; for which reason it is convenient to retain the name for the present.

These beds are very variable, and in many cases intimately associated with the overlying Bunter; and, although there is often great unconformity between the two, the sections bring out strongly the fact that after the close of the Carboniferous period frequently changing conditions took place in Permian and early Triassic times.

The breccias in these beds are composed of fragments of Carboniferous rocks, volcanic ash and other igneous rocks, slates, felspathic grits and quartzites embedded in a sandy calcareous matrix. The fragments are mostly angular, especially in the south. They do not appear to have come from any distance, and most of the fragments may be derived from rocks that occur within 10 or 20 miles. The occurrence of these beds seems to indicate the margin of a large mass of land occupying this part of England, the cliffs of which furnished the débris that was transported a short distance, and mingled with the marls and sands of the neighbouring sea.

The outcrop of these so-called Permian beds occurs only on the west side of the area of Carboniferous rocks which is formed by the Coal-measures at Ashby and the Millstone Grit at Melbourne. On the eastern side of this district, as will be shown presently, there are also breccia beds at the base of the Keuper Sandstone but they are of a different character, and consequently have been included with that formation. The Permian breccias first enter the map a little to the north of Overseal, where they form a good feature on the east side of the village, and have been proved in wells to have a thickness of 15 feet or so. At Linton Heath Road, they appear to have thinned out or are overlapped by the Bunter, but come on again to the north of Mount Pleasant; and, forming a good feature at High Cross Bank, may be traced through Castle Gresley to Stanton, nearly following the course of the high road between these places. A well at High Cross Bank gave the following section :—

Section at High Cross Bank, Castle Gresley.

	Ft.	in.
Soil and sand - - -	5	0
Flaggy marly sandstone with pebbles	5	0
Flaggy marly beds	2	0
Pebbly gravel or conglomerate	4	0
Soft red sandstone - -	3	0
Purple gravel (" Poxon or pox gravel ")	5	0
Total Depth	24	0

In a well on the opposite side of the road and at the same level but about 60 yards distant the "pox gravel," which was 7 feet thick, is said to have been reached at 10 yards; thus showing that the breccia is thicker in the old depressions of the Coal-measures.* About Cadley Hill the outcrop is very obscure, and has been traced chiefly by the help of shallow borings.† At Bretby Colliery (Newhall Park Colliery on one-inch map) a good section of the breccia 62 feet in length was exposed, showing a thickness of 6 ft. 5 in.‡

North of Stanton the outcrop is obscure, and, there being few surface indications, has been mainly traced from the evidence afforded by borings. North of Brizlincote Hall and along the bank north of Newhall, these breccias have not been found, nor is there any evidence of their outcrop along the long promontory, extending by Midway Houses to the railway. In the valley of the Hartshorn Brook they again occur; and good sections are seen in Hoofies Wood near the bridge, and opposite Bugley Cottage, where 15 to 20 feet of red and purple marl with thin bands of breccia are exposed. These beds extend some little distance down the stream, and may be followed along the hill on the opposite side by Caulkley Wood and around Gravelpit Hill, where they were met with in laying the water-mains along the lane, into the valley above Dawson's Rocks. North of this they probably extend down the valley to Milton, as Permian-looking marls have been met with in excavations at one or two places along the sides of the stream and in shallow borings made by Dr. Horace Brown.

After leaving the valley at Dawson's Rocks there is no evidence of these beds until we reach Ticknall. Here, on the northern side of the village immediately above an old quarry in the limestone, there is an old brickyard which has been worked in red and purple marl with a few thin bands of whitish sandstone, and one bed about 8 inches thick of fine breccia. This was formerly mapped as Carboniferous, but it is very different from the shales of that formation, and if not of Permian age, may represent the base of the Trias.

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* Other sections near here are given in the Appendix.

† A large number of shallow borings were made by Dr. H. T. Brown for his paper on the Permian Rocks of the Leicestershire Coal-field (*Quart. Journ. Geol. Soc.* Vol. xlv. p. 1). The results of these he kindly placed at our disposal for the present survey.

‡ Dr. Brown gives a sketch of this section (loc. cit. p. 5), which having been recently cut was then better exposed.

From this point a neck of clayey land extends over the hill to Robin Wood, which represents the outcrop of these beds, and connects them with the somewhat obscure area lying between this wood and Ingleby. This district has been variously interpreted by different authors, the present survey being the third time that these strata have been mapped.

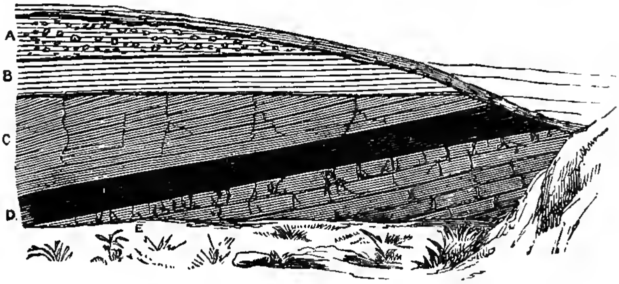
The survey in 1855 by Professor Hull, although it exaggerates the extent of the outcrop, shows the Permian beds nearly in the same position as the present map; but the shaly strata beneath are shown as Coal-measures, and the Millstone Grit, forming the bank to the east, is brought in by a large north and south fault.

Dr. Horace Brown in 1889 published another map of this ground, omitting the fault shown by Professor Hull, but placing one with the same throw further to the west; thus showing the Millstone Grit dipping west under the Coal-measures, which are faulted against the Trias on their western side, and making several other alterations in general detail.

The evidence obtained in the present survey does not seem to bear out either of these views. In the first case there does not appear to be any necessity for a north and south fault. The Millstone Grit, which forms a good escarpment here, has a distinct dip to the east, as is shown in several quarries along the escarpment, and does not dip down this bank as supposed by Dr. Horace Brown. Secondly, there is no evidence for the great north and south fault drawn by Professor Hull; nor, as far as we could make out, for assigning the shaly ground at the base of the escarpment to the Coal-measures. There is not much evidence to suggest what these latter beds are, but there is no reason for considering them otherwise than the shaly beds beneath the Millstone Grit, which would naturally crop out at the foot of the escarpment.

In this area the Permian marls, which extend north from Ticknall, crop out over the wood known as Gorsty Leys, forming wet boggy land, and are exposed in the stream just above the fish-pond south of Knowl Hill. At this point they are thrown down by an east and west fault, but reappear again at the foot of Knowl Hill, and may be followed along the flank of Ingleby Hill to Ingleby, where they disappear beneath the alluvium of the Trent. The marls are exposed at a few places in the stream, and in the two lanes north of Ingleby Hill. They were also found in several shallow borings put down by Dr. Brown. Besides the main outcrop there are several outliers of these beds extending along the ridge between Ashby and Midway Houses. At Ashby some purple marls are seen in the railway cutting, but they are very thin, and it is doubtful how far they extend along the foot of the Keuper escarpment. They reappear at Blackfordby, some variegated marl and breccia being seen in the lane on the west side of the village. This breccia was passed through in the colliery shaft about half a mile to the north-west, where it is 8 feet thick, and was also apparently met with in the old clay pit between these places. This latter section, which is now obliterated, is given by Professor Hull in his memoir on the Leicestershire coalfield.

FIG. 5.—*Clay-pit at Blackfordby. Showing Permian Beds resting on Coal-measures.*



A. Loose breccia in matrix of marl.
B. Purple marl.
C. Sandy shale.
D. Coal, 3 feet thick.
E. Pot-clay, with rootlets stretching from the coal.

North-east of Woodville these beds are not traceable, but they occur again on the outlier at Swadlincote, where the following section, which was exposed in Wraggs Clay Works on the west side of the hill, was measured:—

Swadlincote Sanitary Pipe Works.

	Ft.	in.		Ft.	in.
Red marl	6	0	to	12	0
Red and white sandstones with grey sandy marl, and bands of red marl	15	0			
Yellowish sandstone with a few pebbles in lines	5	0	to	7	6
Pebble bed or breccia with a sandy band. Fragments mostly subangular	2	3	to	4	0
Sandstone with pebbles and thin partings, false-bedded	6	0			
Alternations of sandstone and marl. Lowest marl white, other red	2	6			
Pebbly sandstone, conglomerate or breccia. Purple in lower part, yellow above	4	0	to	5	0
Purple marl with white bands	1	0	to	3	4
Coal-measure clays with five thin seams of coal	About 40 feet seen.				

The average thickness of Permian brecias and marls is about fifteen feet.

This, which is the finest exposure of these beds, was measured in 1896. The Keuper, Bunter, Permian and Coal-measures were shown in one grand section, which is now greatly obscured by the debris that has accumulated against the face of the cliff.

The character and thickness of the beds is very variable, as shown by the great difference in measured sections taken here from time to time as the cliff-face has been cut further back.*

Most of this breccia is very hard and firmly cemented together. An analysis of this cement by J. G. Well is given below.

Analysis of calcareous cement of the Permian breccia from Swadlincote Clay Works from Dr. H. T. Brown.

Calcium carbonate	8·51
Magnesium carbonate	5·04
Ferrous oxide (hydrated) FeH_2O_2	3·57
Ferric oxide Fe_2O_3	·83
Silica soluble in dilute HCl	1·12
Insoluble residue and loss	80·93
	100·00

In the old brickyard on the opposite side of the hill, which has now been worked down, Dr. H. T. Brown gives the following section:—

Section in Brickyard near Sharpswood Farm.

	Ft.	in.		Ft.	in.
Sandy clays and coarse sandstone	2	0	to	3	0
Conglomerate (quartzose) with clay galls, in part current-bedded	1	5			
Grey indurated sand	0	8			
Indurated red marl	1	5			
Fine breccia	0	3			
Red and variegated marl with sandy streaks near top	1	7			
Breccia with a thin argillaceous parting	3	11			
Red and variegated clays with thin bands of fine whitish sandstone	12	0 (about)			
Breccia	3	0 (about)			

A well in the brickyard went through three feet of red clay and eight feet of breccia before reaching the Coal-measures.

At Boothorpe and to the south of Woodville there is a long faulted outlier of these rocks. The beds are best seen in the Boothorpe Pottery Works, where the following section was measured:—

Section in Boothorpe Pottery Works.

	Ft.	in.		Ft.	in.
Soft pebbly sandstone	8	0			
Sandy breccia or conglomerate	2	6			
Purple breccia with a thin band of sandstone in the upper part, thickens east	5	6	to	6	0
Purple marls with white and grey bands	5	0	to	6	0
Grey Coal-measure shales	2	0			
Coal	1	6	to	2	0
Clunch	7	0	to	8	0
Coal	2	4			

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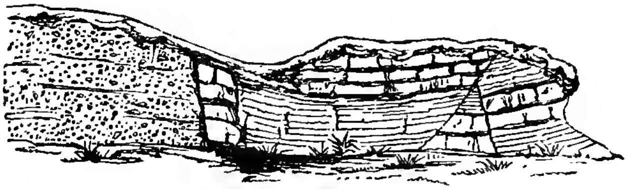
* Compare H. T. Brown, loc. cit., p. 8.

The Coal-measures are much disturbed and highly inclined. The Bunter sandstone at the top is unconformable, and fills in depressions of the breccia. There are indications of the breccia along the bank as far as Boothorpe, but south of that place these beds are not traceable.

A small inlier of Permian breccia occurs at Linton, but the extent of the outcrop is very uncertain. The breccia has been seen in two or three excavations here, and has been proved in wells. On the northern side the Bunter sandstone is at a lower level, but whether this is due to faulting or unconformity there is not sufficient evidence to show.* On the west side these beds are cut off by the large north and south fault that has been proved in the Netherseal Colliery. A section of this fault was formerly exposed in the village of Linton, a sketch of which by Professor Hull is given below.

FIG. 6.—*Section in Lane at Linton.*



Loose breccia. Brown sandstone and marl.
Permian. Keuper.

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* In the workings of Netherseal Colliery which pass near here there is stated to be no fault that would account for the position of the Permian; on the contrary the Coal-measures are rising rapidly towards the north-east.

CHAPTER V.

TRIAS.

The three divisions of the Trias, the Bunter Pebble Beds, the Lower Keuper Sandstone, and the Keuper Marl are well represented in this district. Of these the Keuper Marl covers by far the largest area, the lower divisions appearing principally in the south-west quarter.

BUNTER SANDSTONE AND PEBBLE BEDS.

The only division of the Bunter that occurs in this map are the quartzose conglomerates or pebble beds, which to the west have been considered to represent only the middle portion of that formation. These beds consist in the main of coarse pebbly conglomerates more or less consolidated with occasional beds of sandstone, the whole being excessively false-bedded. The sandstones are so compact and homogeneous that they are sometimes worked into caves. A noticeable instance being the Anchor Church in the bank of the Trent near Ingleby, which consists of several chambers united by short passages. The pebbles in the conglomerate are cemented by light-coloured, fine, calcareous sand, which on weathering forms a rock so hard that the individual pebbles break across rather than leave the matrix.*

These beds crop out almost entirely in the south-west quarter of the map, where they appear to be thickest; they die out to the east, and probably were not deposited much to the east of a line drawn through Castle Donington and Ashby, although the boring at Hathern shows that they were abnormally thick in what is now the valley of the Soar.† They are, however, of no great thickness generally, but are well exposed around the west and north sides of the coalfield, overlapping the thin beds of breccia and marl which have been described in the previous chapter. They also cap the ridge at Midway Houses, and are found on the outliers at Swadlincote and Boothorpe between the productive and unproductive portions of the coalfield.

The Bunter Pebble Beds are, however, best developed further north between Bretby and the Trent at Foremark; over which district they crop out around most of the valleys, but do not cover nearly so large an area as was shown on the old map. Small inliers of these beds also occur near Burton, where they are exposed in Dale Brook, and near Castle Donington where the conglomerate is seen in the bank above the Trent at the north end of Quarry Hill Plantation. The best exposures are the gravel pits near Repton, and the bank above the Trent alluvium west of Ingleby. There are also good sections in the railway at Gresley, and in quarries to the north. In a quarry at Midway Houses the sandstone is more massive than usual in this district.

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* Mr. O. A. Shrubsole states that 80 per cent. of the largest stones consist of quartzites and grits. A useful summary of the literature on the origin of these pebbles is given in this paper. *Quart. Journ. Geol. Soc.*, vol. lix., p. 311.

† See Appendix p. 54.

The great beauty of the scenery about Bretby Park and Repton Shrubs is mainly owing to the outcrop of these rocks.

LOWER KEUPER SANDSTONE AND MARLS.

The Lower Keuper Sandstone and Marls vary in thickness from about one hundred to nearly fifty feet, being thickest in the south and thinning northwards. They are composed of beds of pink and white sandstone with bands of marl. The sandstones occasionally, as about Burton, are fairly massive. At the base they contain beds of breccia which are well seen at Castle Donington and other places, but become most marked on the flanks of the Charnwood Hills, about Thringston and Grace Dieu. Sometimes the beds contain a considerable amount of bitumen; this was well shown in cutting the road at Bearwood Hill, Burton, where the hollows containing this mineral were about two inches in diameter. This bituminous bed appears to occupy a definite horizon which can be traced in the neighbourhood of Winshill and Bladon. The upper part of these beds is much more marly, and it is difficult to fix a division between them and the overlying Keuper Marl. At Weston Cliff, opposite Donington Park, footprints of *Labyrinthodon* have been found in these sandstones.

In the south-west corner of the map the Lower Keuper Sandstone covers a considerable area, and in the neighbourhood of Caldwell the branch line to Netherseal Colliery cuts through these beds exposing several sections in massive sandstones with marly bands having a general dip of about 5° to the south-west. North of this the outcrop forms a narrow strip above the Bunter Pebble Beds as far as Brizlincote Hall, where it turns down the valley to the west towards Stapenhill; and, extending along the side of the Trent, forms the lower portion of the fine bank opposite Burton. The sandstones are well exposed in the road at the Cemetery, in the quarries opposite Trent Bridge, and up the Bearwood Hill road, which is cut to a depth of from twenty to thirty feet in this rock. In the lower part of Winshill there are frequent exposures of soft massive and thin-bedded sandstone, and the same beds have been proved in numerous well sections between here and the Trent.*

Along the bank of the Trent below Bladon Castle these beds form a small cliff extending almost to Newton Solney, east of which they cover a large area of ground as far as Repton. Over this ground there are not many sections, but its loamy and sandy character is very apparent. On the old map a large area of Pebble Beds is shown in the neighbourhood of Foremark, but it is very evident that this formation only comes to the surface in the valleys and lower ground; all the higher part of the region between Repton and Ticknall is covered by the marly beds of the Lower Keuper Sandstone, which is seen in numerous ponds and other excavations, and gives rise to a loamy retentive soil very different from that of the Bunter Pebble Beds. Between Ticknall and Melbourne these rocks have been entirely denuded, but east of the latter town they form a good bank which is continued along the south side of the Trent as far as Castle Donington, where the basement beds contain a considerable amount of breccia.

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* See Appendix, pp. 62, 63,

East of Castle Donington these beds are thrown down by a fault, but crop out again at Kegworth, where they dip to the south-east, and finally disappear beneath the alluvium of the Soar. The sandstones are exposed in the town, and the upper part shows that they are ripplemarked.

A small outcrop of these sandstones occurs on the north side of the Trent at Weston. It is quarried as a building stone at the railway junction, and consists of massive beds of sandstone, some of which are full of cavities, the beds above being more flaggy and marly with ripplemarks.

South of Melbourne these beds form a good escarpment on their west side, and crop out in the valleys around Breedon, gradually rising to the southward till they reach the summit of the escarpment running from Staunton Harold to Thringston. This escarpment is shown on the old map as a line of fault, which has an upthrow to the north in the Coal-measures, but a downthrow in the Trias. Now there is no doubt a large fault exists here that throws the Coal-measures out on the north side; but it does not appear to affect the Triassic rocks, which end off in a normal escarpment, the outcrop bending round quite naturally in the various transverse valleys. Between Griffydam and the Charnwood Hills the breccia noticed above becomes much more developed, and appears to form the greater part of these rocks, taking the place of much of the sandstone that occurs to the west. Good sections of these breccias are exposed in the village at Thringston, and in the limestone quarry at Grace Dieu.

A considerable outcrop of these beds occurs in the Cole Orton district, the sandstone forming a series of spurs between the small valleys, but on the higher ground is hidden by Drift, although a good exposure is seen in the Midland Railway.

North of Ashby there is a large outlier of these beds forming the bold escarpment of the Pistern Hills. The outcrop above the Coal-measures is here very sharp and distinct, except in the extreme north near Smith's Gorse, and in the extreme east near Lount Wood, where it may extend further than shown on the map. A good deal of the higher part of these hills is hidden by Drift.

KEUPER MARL.

The Keuper Marl occupies by far the largest area of any formation, covering at least three-quarters of the entire map. Although these marls are usually conformable to the sandstones below, there being a gradual passage from one to the other, still in the neighbourhood of the old land surfaces such as the Charnwood Hills there is a distinct unconformity, the marls overlapping and resting directly on the older rocks.

These beds consist of red and grey marl with occasional thin bands of white sandstone or "skerry," which are never of much importance in this area; in fact there is only one band, that cropping out on the hill south of Castle Donington and Kegworth, which is traceable on the map. Beds of gypsum occur in these marls, the most notable being those at Chellaston and near Gotham, at both of which places they are mined. Gypsum is also found in the brickyards at Winshill; and there is an outlier of it at Bellington Hill north of Aston, where it appears to have been worked. At Chellaston the gypsum varies from six to twelve feet in thickness.* The beds are usually much worn and rounded by chemical action, so that in the mines the gypsum is often separated by partitions of marl, and in those cases it is worked between the marl, which is left in pillars. It has been stated that the marls at Chellaston contain Foraminifera;† but owing to the strong Liassic facies of the species it was always doubted if they came from the Trias; it is probable, therefore, that the Foraminifera in question came from the Drift, which, no doubt, is largely made up from the debris of the Lias.

At Winshill there is a bed of cupriferous sandstone in the marl, about 2 ft. 9 in. in thickness, which is well exposed in the brickyards on the south side of the Ashby Road.‡

The Keuper Marl, as we have said, covers about three-quarters of the map, but this may be divided into five areas; that lying between the Charnwood Hills and the Trent; that between the Trent and the Derwent; that north of the Derwent; that east of the Soar; and that flanking the Trent at Burton.

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* It is stated on one of the mining plans deposited at the Home Office that the gypsum is eighteen feet thick, but this must have been exceptional, as the miners say they never knew it this thickness.

† T. Rupert Jones and W. K. Parker. *Quart. Journ. Geol. Soc.*, vol. xvi., pp. 452, 456; *Ibid.*, vol. xl., p. 771; W. D. Crick and C. D. Sherborn, *Journ. Northamptonshire Nat. Hist. Soc.*, vol. vii., p. 68; and T. Rupert Jones, Crag Foram. (*Pal. Soc.*) Pt. 2, p. 161, Footnote.

‡ The detail of this section is given on p. 62.

The first of these, north of the Charnwood Hills, dips to the east and consequently is thickest along the Soar valley towards Loughborough; but, becoming much thinner towards the west, forms several outliers capping the higher ground near Breedon. Between here and Loughborough the hills are mostly covered by Drift, so that it is only in the valleys and along their flanks that the Keuper Marl appears. A thin bed of sandstone occurs in these measures not far from their base, which can be followed along the slopes of Donington Park, and along the brow of the hill, to Kegworth. It also comes up as an inlier in the valley to the south at Diseworth, where it is of considerable thickness. This sandstone hardens on exposure, and was formerly used to a small extent for repairing roads and for building. In the district lying between the Trent and Derwent the Keuper Marl rises to a conspicuous hill at Chellaston, where it is covered by an irregular deposit of Boulder-clay and gravel; but west of this, except along the high ground about Mickleover and Littleover, it generally comes to the surface, forming the low undulating country to the south-west of Derby. Along the flank of the Trent and about Etwall it is much hidden by terrace gravels.

The Keuper Marl north of the Derwent lies principally in the map to the north; the small portion that comes into this area is mostly covered by Drift and later gravels. There are several bands of thin sandstone in this district, but they are not of sufficient importance to map. It was attempted to do so on the old survey, but the outcrop was much exaggerated; and, although probably faulted, the structure cannot be delineated with any certainty.

East of the Soar the Keuper Marl is exposed along the flanks of the conspicuous range of hills to the north of West Leake, which are capped by the Lias outliers. It also forms bold escarpments along the south side of the Trent at Thrumpton and Clifton Hall. South of West Leake the beds are much covered by Drift and other superficial deposits, but good sections are exposed in the Midland and Great Central Railways.

The fifth and remaining district includes the small area of Keuper Marl to the east of Burton. This is the edge of the extensive outcrop, stretching away to the west of the town, which here abuts against the north-west end of the Coal-measure anticline. The beds are consequently somewhat uplifted, and the Keuper Marl is found occupying the higher portions of the hills between Burton and Repton. The best sections in the Marls are in the brickyards at Winshill. Here in the brickyard south of the Ashby Road there is a bed of sandstone 3 feet thick, the upper part of which is impregnated with carbonate of copper; below this are red marls containing much gypsum in the lower part. The marls are seen in several small openings about here, but further north sections are rare, and the separation of the marl from the underlying sandstones is not very definite.

RHÆTIC BEDS.

East of the Soar valley there are three patches of Lias and Rhætic beds. The southernmost of these at Normanton Hills is the end of a long promontory running out from the main outcrop in the next map; the other two are outliers of the same. The outcrop of the Rhætic beds fringes these hills in a very regular manner, forming a good feature along their flanks, but there are very few clear exposures of the beds. The best section was exposed at the north end of the railway tunnel at Normanton Hills, where there are 20 feet of dark laminated shales resting directly on the tea-green marl. Above this there are 25 feet or more of grey shale with thin limestone, the upper part of which should be classed with the Lias, but there is no good line of separation between them. Mr. Montagu Browne, who gave a detailed account of this section at the time it was made, mentions the following list of fossils from this place*:—

Fossils from the Rhætic Beds, Normanton Hills.

PLANTÆ.

Pterophyllum (*? brevipenna*), Heer.

INVERTEBRATA.

Pecten valoniensis, Defrance.
Avicula contorta, Portlock.
Myophoria inflata, Emmerich.
Cardium philippianum, Dunker.
Isodonta Ewaldi, Bornemann.
Anatina præcursor, Quenstedt.
Actæonina (*? Valleti*), Stoppani.

VERTEBRATA.

Hybodus minor, Agassiz—teeth.
Acrodus minimus, Agassiz—teeth.
Nemacanthus monilifer, Agassiz—spines.
Gyrolepis Alberti, Agassiz—scales.
Labyrinthodon sp.—parts of jaws and teeth, and other portions not yet determined.
? Dinosaurian limb-bones.
Rysosteus Oweni, Woodward and Sherborn.

The junction of the dark shales with the tea-green marls is very sharp and well defined, but there is no appearance of a bone-bed between them, although Mr. Browne states that a piece of this breccia was found in the spoilheap from this cutting.

Further north the Rhætic beds crop out around the flanks of the conspicuous outlying hills between West Leake and Gotham. Dark laminated shale with *Avicula contorta* and other bivalves was seen in an excavation at the north end of Ash Spinney, and again in the ditch at the east end of Crownend Wood. At this latter place the band of nodular septariform limestone occurs, marking the upper portion of these beds. Similar indications are seen at other points round the hill; and from the strong contrast in colour between the shales and marls the division between the two is not difficult to fix.

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* *Rep. Brit. Assoc.* for 1895, p. 688.

On the northern outlier dark laminated shale with *Protocardium philippianum* and other bivalves was thrown out from a well at the side of the lane on Cottagers Hill. These shales are also seen in the spoilheaps from some of the gypsum shafts north of Gotham, but the beds appear to be thinner here, and the outcrop is not so distinct as to the south.

At Winking Hill there is a patch of limestone which is much shattered, and appears to rest directly on the tea-green marls. There being no intervening shales here it is probable that this mass has slipped over the Rhætic beds from the slightly higher outcrop to the east.

CHAPTER VI.

THE LIAS.

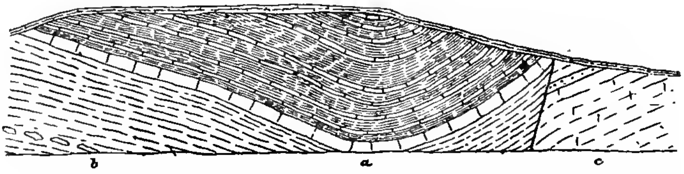
The lowest portion of the Lias just comes in on the east of the map capping the three outcrops of the Rhætic beds mentioned above. At the south end of the Normanton Hills tunnel there is a good exposure of these beds, where the following section was measured:—

Section of Lower Lias, Railway Cutting, Normanton Hills

	Ft.	in.
Limestone		
Shale		
Limestone		
Shale		
Limestone		8
Shale	2	0
Limestone		8
Shale	3	0
Limestone		4
Shale	1	0
Sandy shale		10
Limestone, full of *Ostrea liassica*		7
Sandy limestone and shale	1	6
Shale		6
Limestone		8
Shale		8
Limestone		10
Shale	13	0
Band of limestone nodules (Rhætic)		10

There are here nine distinct beds of limestone with intervening shales, which dip rather rapidly to the south, but are turned up by the great bounding fault so that they form a shallow syncline, as shown in the illustration.

FIG. 7.—*Railway Cutting, Normanton Hills, Section showing Lower Lias faulted against Keuper Marl.*



a. Lower Lias shales with thin beds of limestone; some of the be crowded with *Ostrea liassica* and other fossils.
b. Band of nodular limestone with Rhætic shales below.
c. Red Keuper Marl with grey streaks, and a thin bed of sand stone in the upper part.
Average dip about 6°, turning up against the fault to as much as from 25° to 58°. Section much foreshortened.

It is probably owing to being let down by the fault that so considerable a thickness of these limestone beds has been preserved at this place.

On the two outliers near Gotham similar beds of limestone and shale are seen, more particularly at a few old quarries on West Leake Hills, where seven or eight bands of limestone have been worked. The beds are very flaggy, and contain *Ostrea liassica* in great abundance.

The regularly bedded character of this portion of the Lias gives rise to characteristic flat-topped hills with sharply cut escarpments. The soil is cold and poor, and mostly devoted to plantations.

CHAPTER VII.

PLEISTOCENE AND RECENT.

GLACIAL.

The Drift deposits as we proceed northwards in this district are not nearly so thick and important as they were in the map to the south. It was noticed in the description of that country that these beds were becoming less important on the western side of the Soar valley. As we trace them northwards there is a still further attenuation, so that in this district they are found principally capping only the relatively higher ground. In fact they form the small remaining portion of a vast sheet declining towards the Trent valley, which has now been almost entirely removed by the denudation of the small tributary streams. Consequently the Drift colours shown on the map, in most cases, pick out the relatively high ground; the notable exception being the Charnwood Hills, which stand above this level. For this reason sections in the Drift are rare; but wells and other excavations have been made at a few places, which afford evidence as to its character.

At Cole Orton Hall chalky Boulder-clay was turned out in excavating for the gasometer; but as it is usually not very thick about here, it is possible that this is on the line of one of the channels filled with Boulder-clay crossing the railway to the south, and mentioned in the description of that sheet.*

The Drift caps the conspicuous hill above Burton known as Waterloo Clump, and is seen resting on the Marl in the brick-yards below. It is a very coarse and irregular gravelly clay or dirty gravel containing boulders of Millstone Grit, granite, chert, limestone, and many rounded quartzite pebbles, but apparently no Chalk or Jurassic rocks. A boring at the 400 contour-line proved 16 feet of Boulder-clay.

At the south end of Bretby Park good stiff chalky Boulder-clay was seen, but it appears to pass off into gravel towards the south-east. A good deal of gravel with flints also covers the hill about Greysich south of Repton Shrubs.

To the west of Derby along the ridge from Mickleover to Littleover a considerable amount of Drift caps the higher ground. It consists in great measure of coarse gravel containing large pebbles and flints, but is too clayey and impure to be separated from the Boulder-clay or to be shown on the map as a gravel. One of the principal masses of Drift is perhaps that which occurs at Chellaston, and which covers much of the comparatively low ground between the Trent and Derwent. This appears partly to occupy an old valley, as it caps the hill above the village, and also descends to the south to the level of the Trent alluvium. It is cut through by the railway, and a deep section was exposed in the cutting south of the station. It is chiefly composed of stiff clay with striated blocks of Carboniferous limestone, Lias, and flints; but on the north side of the hill in the old brickyard at Shenton Lock a lower Boulder-clay is seen, which contains quartzite pebbles without any Chalk fragments or flints. Whether this older deposit extends for any distance it is impossible to say, but apparently it does not. It probably occupies small depressions in the Keuper Marl here and there beneath the more general Chalky Boulder-clay.*

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* Memoirs of the Geological Survey (Explanation of sheet 155, p. 39).

In many cases it is impossible to separate out the gravels from the general mass of the Drift without giving too much importance to these gravels, and therefore the blue colour shown on the map occasionally includes areas that are distinctly gravelly. Besides this, however, there are many places where the gravels can be mapped separately. This is especially the case along the northern foot of the Charnwood Hills, and in the low ground west of Castle Gresley, where the Drift beds may have been subjected to a greater wash. Besides these there are also patches of gravel on the hill-tops at Bretby, Greysich, Ashby, Chellaston, Castle Donington, and West Leake.

The greatest elevation that the Drift attains in this district is on the Pistern Hills, where it occurs slightly above the 600 contour-line. It also attains nearly this height on the Charnwood Hills near Longcliff; and further south rises to a somewhat greater elevation.

With the exception of the two distinct Boulder-clays on the north side of Chellaston there is very little evidence in this district for a classification of the glacial deposits. Mr. Deeley has treated of the surrounding districts at some length † but as we have stated our views on the subject elsewhere,‡ we need not return to it here. When the country to the east, which includes more typical ground, is surveyed, it is possible that further evidence may be obtained on the character and relation of these beds to one another.

POST GLACIAL.

HIGH LEVEL VALLEY GRAVEL.

The oldest of the Post-glacial beds are those to which the name High Level Valley Gravel has been given. These gravels are found flanking the Trent and Derwent valleys, and cap much of the high ground formed by the first rise of the Keuper

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* Mr. W. T. Tucker informs us of a similar case at Far Park Lane, S.W. of Loughborough, where 40 feet of purple Boulder-clay containing foreign erratics was proved in a well within a very short distance only of the outcrop of the Keuper Marl.

† *Quart. Journ. Geol. Soc.*, vol. xlii., p. 437.

‡ The Geology of the country near Leicester (Explanation of sheet 156) p. 43, *et seq.*

Marl above the more recent alluvial beds. They occur almost entirely on the northern sides of these two valleys. The reason for this is not very obvious but shows that the tendency of the rivers has been to cut fresh channels to the south. These gravels are intimately associated both with the glacial beds and with the modern river terraces; in fact, they form a passage between Glacial and Post-glacial times. For this reason, in some cases, it is difficult to separate them from older beds, in other cases, from newer beds.

Between Etwall and Eggington these gravels form a broad terrace from twenty-five to fifty feet above the river; and north of the former village, rise to rather more than a hundred feet above that level. They cap the higher ground at Findern, Stenson, and Barrow-hill, forming a ridge which overlooks the Trent valley on one side, and the low ground towards Derby on the other.

Along the Derwent valley these gravels occur in a line of disjointed patches at Spondon, Borrowash, Draycott, and Breaston, forming a terrace about forty feet above the river, the continuity of which has been broken up by the denudation of the small transverse streams. In the town of Derby there is a bank of this gravel along the Osmaston road at the back of the Infirmary, which is from sixty to eighty feet above the present river. In nearly all cases these gravels end off in a steep bank towards the river except at Weston and Aston, which are at the end of the promontory dividing the two valleys; where, as one would expect, the gravels are washed down, and difficult to separate from the later river terraces.

These gravels consist principally of quartzite pebbles and flints, their size varying from a few inches in diameter to that of a walnut or even smaller. They are usually clean and well stratified; in some cases they contain lumps of clay and the bedding is disturbed, as if ice were floating about at the time of their deposition, but we could find no evidence of their inter-glacial age as has been suggested.

RIVER TERRACES.

All the main rivers of the district are flanked by well-marked river terraces. These are composed mainly of well stratified gravels very similar in character to that forming the High Level Valley Gravel. They form terraces at from fifteen to twenty feet above the present alluvium, from which they usually rise in a sharp bank. Where, however, tributary streams connect, as the Dove below Eggington, the Soar below Kegworth, and the Erewash below Long Eaton, the separation is not so distinct, and these earlier terraces become mingled with the more recent river deposits. A large area of these gravels extends along the south side of the Derwent from Derby to Aston, forming the extensive plateau on which Osmaston, Boulton, Alvaston, and Elvaston are situated. They contain mammalian remains. Bones of *Hippo-*

potamus, *Elephas* and *Rhinoceros* have been recorded at Allenton;[*] *Bison priscus* at Kegworth and *Elephas primigenius* at Loughborough and Kegworth.[†] Mr. Bemrose gives the following section of these beds at Allenton.

Section in river deposits at Allenton.

	Ft.	in.
Surface soil and clay with a few quartzite pebbles	2	8
Yellow sandy clay with a few pebbles near the top; nearly free at the bottom -	2	7
Yellow tough clay - - -		4
Blue, tough sandy clay, with rootlets and an occasional quartz-pebble - - -	1	4
Dark coloured sand containing numerous pebbles, plant-remains, bones of *Hippopotamus*, etc. -	2	9
River gravel (not bottomed here) with many limestone and chert-pebbles -		

Although these terraces are mainly composed of gravel they are not entirely so. In some cases a considerable portion of them is formed of clay or loam. This is noticeably the case along the northern part of the terrace that runs from Draycott and Breaston to the east, these villages being on gravel; while towards the canal, and parallel with it, there is a channel mostly filled with clay.[‡] The western part of this Mr. Deeley has mapped as an overlying boulder-clay, but there is no evidence of its being of glacial age, nor against its being contemporaneous with the gravel; the latter would naturally be principally deposited near the stream, while clay and loam would accumulate in the more tranquil region beyond.

LACUSTRINE CLAY.

Many of the hollows in the Keuper Marl are filled with lacustrine deposits which have been laid down at a time when the drainage of the country flowed at a slightly higher level, and which are therefore in great part contemporaneous with the terraces just described.

The largest of these is that covering the hollow of Sinfin Moor, which has an area of about two square miles. It forms a nearly level spread of clay and silt with so much decayed vegetation in places as to be quite dark and peaty, although there is scarcely sufficient to constitute a true peat. The following section is given by Mr. Deeley at this place.[§]

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[*] H. H. A. Bemrose and R. M. Deeley. *Quart. Journ. Geol. Soc.* vol. lii. p. 500.

[†] Moutagu Browne, "Vertebrates of Leicestershire," 1889, p. 27.

[‡] These are shown by the same colour on the map, but the gravel is distinguished from the more clayey areas by having the symbol placed upon it.

[§] *Loc. cit.* p. 502.

Excavation on Sinfin Moor.

	Ft.	in.
Black peat - -	1	2
Disintegrated shells		3
Stiff yellow clay	2	0
Shells -	2	0
Quicksand	3	0
	8	5

There are other small basins filled with this clay to the north of Findern, and a much larger one to the east of Gotham, but only the edge of this comes into the area under consideration. This latter probably covers an area of nearly four square miles, but the whole ground has not yet been surveyed. The deposit is a white marl with much vegetable matter; it contains plants, but the specimens yet obtained are too decayed for identification. In the Erewash valley, close to Toton sidings, a stiff marly clay with shells occurs beneath the present alluvium of the stream in which the following species, which have been identified by Mr. Clement Reid, were found:—

Shells, etc., from the Erewash Valley.

Sphærium corneum, Linn.
Paludina sp.
Limnæa pereger ? Müll.
Valvata piscinalis, Müll.
Bythinia tentaculata, Linn.
Chrysalis cases (several sp.).
Daphnia (winter eggs).
Scirpus lacustris, Linn.
Lycopod (spores).

ALLUVIUM.

Owing to the several important streams—the Trent, the Dove, the Derwent, the Soar, and the Erewash uniting in this map there is a large spread of alluvial clays and gravels, which have a thickness of from 20 to 30 feet.* These occur at two slightly different levels, but they so frequently pass imperceptibly one into the other that it is not possible to separate them definitely. For this reason they are shown by only one shade of colour on the map, the boundaries between them being drawn, and distinguishing symbols used only where the distinction between them is clear. In a general way the older alluvium, which is above flood-level, may be said to cover the greater part of the river plain. It forms a gravelly soil that is principally devoted to arable land; while the newer alluvium of the present river, which is deposited in channels that have been cut in the older beds, generally forms meadow-land. During the construction of the Great Central Railway across the Soar Valley at Loughborough in 1895, a fine skull with horn-cores of *Bos taurus* var. *primigenius* was found embedded in the upper part of the clay at a depth of about 12 feet beneath gravel and alluvium at the spot where the old road to Stanford abuts on the new course of the river Soar.*

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* *See* Appendix p. 51, *et seq.*

The larger rivers flowing along this plain have frequently altered their courses, and the tracks of the old channels can still be followed in many cases. A noteworthy case is the old channel of the Trent at Repton, which is of historical interest from being mentioned by Shakspeare.† This is said to have been altered artificially, so that an area of over 300 acres, which was formerly on the north side of the river, is now on the south, or Repton side. Between Shardlow and the Soar these old channels are very numerous: there is a marked one on the north side of Attenborough, which probably at one time took the water of the Erewash.

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* We are indebted for these particulars to Mr. J. T. Judges. The specimen is now in the Loughborough Museum. Sections in the river beds here are given on page 58.

† Henry IV., Pt. i., Act III., Sc. i.

CHAPTER VIII.

PHYSICAL STRUCTURE AND FAULTS.

This map comprises the northern end of the two anticlinal folds by which the older strata, the pre-Cambrian and Carboniferous rocks, have been uplifted. These axes run in a north-west direction; the one crosses the Charnwood Hills and runs between Lubcloud and Longcliff through Ives Head and Blackbrook; the other, which only affects the Coal-measures, runs through Ashby and Hartshorn, beyond which it is lost beneath the Trias. Besides this there is a large strip of Carboniferous rocks on the east side of this anticline, which has been uplifted between two large faults, and bent into a shallow syncline running from the north-west corner of the Charnwood Hills through Worthington and Melbourne to the Trent.

These three folds form the main points in the structure ot the country. Throughout the rest of the district the older rocks are overlapped by the Trias, which lies fairly evenly over them, and what other disturbances there may be in these strata is not known. This folding of the strata has given rise to several large faults running parallel to these north-west axes, the evidence for which will now be described.

BREEDON FAULT.

This fault runs from the Charnwood Hills near Grace Dieu on the east side of the string of limestone outcrops at Osgathorpe, Barrow Hill, Breedon Cloud, and Breedon, and thence probably through Wilson to the east of King's Newton. The exact position of this fault is everywhere hidden by the overlap of the Trias, the outcrop of which it does not affect. It is consequently not shown on the map, but it is evident that it cannot be far from the outcrop of the limestone, which at Breedon Cloud and Breedon is greatly disturbed, and dips to the west at about 70° Further north in the brickyard at King's Newton there is also evidence of this fault or of one parallel to it. Here the base of the Millstone Grit with shales and thin limestone bands below dips at an angle of 45° to the west, and is faulted against higher sandstones that dip 10° to the east.

THRINGSTON FAULT.

This is the large fault which bounds the Charnwood Hills on their western side, and which has bent up the Coal-measures at Whitwick into a vertical position as stated in the description of the map to the south.*

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* Memoirs of the Geological Survey. Explanation of Sheet 155, p. 44.

It runs through the village of Thringston, along the north-east edge of the Coal-measures, and consequently has been called the Boundary Fault of that formation. The old geological survey of this district represents this fault as forming the boundary between the Coal-measures and the Trias, and consequently having a throw in post-Triassic times in the opposite direction to what it has in the pre-Triassic rocks. But this is an error. The edge of the Trias between Thringston and Staunton Harold is a natural outcrop, and just overlaps the line of the fault between these places. Its exact position here is therefore obscured, but where it crosses the transverse valleys some evidence has been obtained.

A very short distance north of the Pumping shaft at the Old Swannington Colliery the beds are said to rise rapidly, and to be too much disturbed to be worked; while at the surface some of the highest coal seams crop out, and are within a very short distance of the Millstone Grit seen along the valley south of Thringston Mill. In the valley below Griffydam the position of the fault is more difficult to fix, but it is probably not far from the Chalybeate Spring, which breaks out here. The base of the Trias runs down into the bottom of the valley, and it is possible that the fault crosses north of this point.

At Newbold the fault passes north of the Clay Works at the side of the railway, where at 400 yards from the shaft the strata are stated to be on end. Vertical strata were also found in the foundations of the Inn.

At Smoile Wood the Main Coal is at the surface, and the measures are striking nearly north; while the boring at Warren Pool, which is only 500 yards from the edge of the Trias, was sunk to a depth of 180 feet without meeting with any coal-seams.*

At Staunton Harold the line of fault leaves the overlap of the Trias, and its course can be more easily traced by the juxtaposition of the Coal-measures with the Millstone Grit and Limestone Shales. It passes thence south of Calke Abbey and Ticknall, cutting off the Millstone Grit beds rather sharply, although its exact position is not very definite, and the amount of throw has become considerably less before it is hidden by the Trias at Ticknall.

COLE ORTON FAULT.

Branching from the fault just described at Heath End, and running southwards, there is probably another dislocation having a downthrow to the east, which is supposed to terminate the workable seams of this part of the Coalfield on their western side. The evidence for this fault is so very vague that we have not attempted to trace it for any distance on the map. It probably branches from the Thringston Fault, just north of

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* The Geology of the Leicestershire Coalfield, p. 66.

Heath End, and passes just west of these coal workings and those of Lount Wood. Thence it runs west of Cole Orton Hall and is possibly the cause of the channels filled with Boulder-clay that are seen in the railway west of the bridge at Sinope, mentioned in the description of the country to the south.

BOOTHORPE FAULT.

This is the next large fault which brings in the workable coal seams beyond the anticline of unproductive measures. It is the fault mentioned in the description of the country to the south as running from the north of Measham through Willesley Park to the east of the Moira Collieries. In this map it passes to the west of Blackfordby, throwing in a long narrow strip of Trias extending to Woodville. It is well shown in the clay pits and railway cutting at this place, the junction between the porous Bunter Sandstone and the Coal-measure clays being very sharp and distinct. Thence it passes across the Trias outlier of Round Hill at Swadlincote, and is seen again in the railway-cutting 700 yards east of Swadlincote station, where the beds are vertical. It is also met with in the clay workings under Round Hill, but whether the overlying Trias is affected by the fault is not clear. It is very probable that the long projection of these measures to the north is caused by it, but its effect on the Trias must be very little.

At Midway Houses it passes beneath the overlap of the Bunter, and probably cuts off the workable Coal-measures a little north of the Burton Road.

NEWHALL FAULT.

Throughout the western coalfield there are a large number of faults, which have been proved in the different collieries, and are shown on the map. Most of these run in a more or less east and west direction, and have a small amount of throw. The largest fault within this portion of the district appears to be one on the north side of Newhall, which runs south-east through Swadlincote station. This fault is stated to have a throw of 150 yards down to the north-east, and consequently brings in again the Main Coal and other seams which have cropped out on the north side of Newhall.

LINTON FAULT.

At Linton there is a large north and south fault having a downthrow to the west of 250 yards or more.* This fault is worked up to in the Netherseal Colliery, but the measures beyond have as yet only been proved by borings. The Coal-measures are much disturbed in this district, and it is probable that this is not far from the western limit at which the coal seams can be worked successfully. The Permian breccia and Bunter Pebble beds, which crop out in the village of Linton, are thrown down by this fault as shown in the sketch given on page 29, and disappear beneath the higher beds of the Trias.

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* Mr. G. J. Binns states that the throw of this fault is 279 yards.

NORMANTON HILLS FAULT.

At Normanton Hills there is a fault which bounds this promontory of Lower Lias on the south side. This fault was well seen in the railway cutting here, as shown in the sketch given on page 37.

The junction of the Lias with the Keuper Marl is very sharp and distinct, and where the ground is not covered by Drift can be easily traced.

This fault is the continuation of one that is well marked in the country to the east at Hoton, and probably extends much farther in this direction. In this map it appears to strike northwest and is possibly the same as the fault seen near Castle Donington, which is in the same line but cannot be traced across the intervening marls.

At Hemington the fault cuts off the Keuper Sandstone of Castle Donington, and brings in the marl in the lower ground at the village, but it cannot be traced for any distance.

FOREMARK FAULT.

This fault is first recognised close to the edge of the Millstone Grit at the south end of Robin Wood, where it brings down on its north side the Keuper Sandstone of Knowle Hill and Coppy Hill against the purple clays cropping out below the Bunter to the south of these places, and giving rise to a tract of wet land, which culminates in the noted springs of Seven Spouts. West of this the line of fault runs at the foot of a conspicuous bank formed of Bunter Sandstone, bringing in marly beds of Keuper Sandstone in the lower ground to the north.

At Foremark Park it makes a sharp bend to the south, but soon recovers its previous directions, and may be traced across the park to the alluvial flat north of Milton by the conspicuous break it makes in the sub-divisions of the Trias.

WINSHILL FAULT.

On the east side of the Trent at Burton there is a small north and south fault, having a downthrow to the east, which was first noticed by Dr. Horace Brown. It is proved in the brickyard near the Church at Winshill, where it brings down the marls worked in the pit against the Keuper Sandstone. Its course may be followed in the fields above by the sharp change in the character of the soil along this line; and the well sections in the neighbourhood show the general displacement in the strata A small fault throwing down to the south-east three feet, seen in the Keuper Sandstone bank at Bearwood Hill, is probably a parallel dislocation to this.

The small fault on the north side of Ashby is apparent from the relative position of the Keuper Sandstone on either side. A hand-boring by Dr. H. Brown, at the side of the road, also proved Coal-measure shales on the north side of the fault.

APPENDIX.

BORINGS AND PIT SECTIONS.

Only a few sections are given in this memoir. A fuller list will be published in the more detailed memoir on the Coalfield.

BORING AT ROUND HOUSE, EGGINGTON COMMON. 200 O.D.

From Mr. G. T. Lynam.

——	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Well	62	7	62	7
Coarse sand with quartz fragments	2	5	65	0
Red marl, soft	20	0	85	0
Red marl, harder	15	0	100	0
Red marl with hard bits and gypsum	29	0	129	0
Hard marl, more sandy	15	0	144	0
Red marl, soft	20	0	164	0
Sandstone with gypsum	28	0	192	0
Red sandstone with gypsum	43	0	235	0
Finer sandstone with gypsum	2	0	237	0
Red sandstone with gypsum	6	0	243	0
Grey sandstone with gypsum	3	0	246	0
Red sandstone with gypsum	26	0	272	0
Fine light-coloured sandstone	8	0	280	0
Red sandstone with gypsum	2	0	282	0
,, ,, ,,	11	0	293	0
Fine red sandstone	24	0	317	0
Red marl, soft	15	0	332	0
Fine red sandstone	1	0	333	0
Red marl, soft	16	0	349	0
Coarse red sandstone	4	0	353	0
Finer red sandstone	6	0	359	0
,, ,,	8	0	367	0
Red sandstone	1	0	368	0
Finer red sandstone	7	0	375	0
Coarse pebbly bed	3	0	378	0
Coarse sandstone	6	0	384	0
Fine red sandstone	6	0	390	0
Coarse greyish pebbly bed	11	0	401	0
Red sandstone	9	0	410	0
Fine sandstone	9	0	419	0
Marly sandstone	2	0	421	0
Sandstone, reddish	2	0	423	0
Sandstone, greyish red	3	0	426	0
Marly sandstone	6	0	432	0
Purplish sandstone	4	0	436	0
Coarse purplish rock with fragments of grey rock Plenty of water obtained, but very hard.	4	0	440	0

Boring at Parkhill, Eggington. 170 O.D.

From Mr. G. T. Lynam.

——	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Mostly reddish sandstones	307	0	307	0
Coarse pebbly bed	2	0	309	0
Mostly reddish sandstones	34	0	343	0
Plenty of water, but rather hard.				

Borehole at Milton. 132 O.D.

From Mr. George Hodson.

——	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Surface soil	5	0	5	0
Gravel	18	0	23	0
Marl	72	0	95	0
Sandstone	5	0	100	0
Conglomerate	61	0	161	0

Cavendish Bridge Brewery, 1876. 100 O.D.

From Messrs. Le Grand and Sutcliff.

Water level 10½ feet down. Yield 5⅐ gallons a minute.

——	Thickness		Depth from Surface.	
	Ft.	in.	Ft.	in.
Dug well	30	0	30	0
Soft marl	8	0	38	0
Red marl	6	0	44	0
Red marl and gypsum	20	0	64	0
Red marl and blue stone	2	6	66	6
Blue stone and gypsum	3	6	70	0
Blue stone	1	0	71	0
Red marl and gypsum	2	0	73	0
Marl and gypsum	58	0	131	0
Marl and blue clay	4	0	135	0
Red and blue marl	2	6	137	6
Marl and gypsum	2	6	140	0
Hard stone	2	0	142	0

SECTIONS ALONG THE TRENT VALLEY.

From Mr. George Hodson.*

BOREHOLE No. 1.—Sawley. 98 O.D.

——	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Surface soil and gravel	4	0	4	0
Sand	2	0	6	0
Coarse gravel	7	0	13	0
Sand	6	0	19	0
Very coarse gravel	6	0	25	0
Soft red marl with bands of grey skerry	6	0	31	0
Soft red marl with veins of gypsum	4	0	35	0
Red marl with skerry beds and veins of gypsum	102	0	137	0
Grey sandstone (skerry) and partings of marl	3	0	140	0
Red marl and thin bands of sandstone	2	0	142	0
Very hard sandstone (skerry)	1	4	143	4
Soft marly sandstone	1	0	144	4
Very hard sandstone with traces of gypsum	10	10	155	2
Red marl	8	0	163	2
Skerry	1	0	164	2

BOREHOLE No. 2.—Mr. Porter's First Field, Weston. 120 O.D.

——	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Soil	–	6	–	6
Sand and gravel	6	0	6	6
Red marl with bands of skerry	103	0	109	6

BOREHOLE No. 3.—Mr. Porter's Second Field, Weston. 120 O.D.

——	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Gravel and sand	14	0	14	0
Red marl	8	0	22	0
Sandstone	11	0	33	0
Blue flakes (marl)	1	0	34	0
Red marl	2	0	36	0
Sandstone	3	0	39	0
Coarse sandstone	14	0	53	0
Finer sandstone	21	9	74	9
Sandy marl	3	0	77	9
Sandstone	10	0	87	9
Red marl and skerry bands	64	9	152	6

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*An abstract of these is published in a paper on the Long Eaton Water Supply read before the Association of Municipal Engineers, 1893.

BOREHOLE NO. 4.—Glebe land between No. 3 and Trent.

——	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Gravel and sand	16	0	16	0
Red marl	8	0	24	0
Red and grey sandstone	10	9	34	9
Blue flakes (marl)	1	0	35	9
Red marl	1	6	37	3
Coarse sandstone	19	6	56	9
Hard sandstone	20	3	77	0

BOREHOLE No. 5.—Trent bank. 115 O.D.

——	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Surface soil and red sand	4	0	4	0
Dark sandy mud	10	0	14	0
Gravel and sand	6	6	20	6
Grey sandy marl	12	6	33	0
Red and grey marl (sandy)	15	0	48	0
Red marl and skerry bands	6	0	54	0

BOREHOLE No. 6.—Mr. Brigg's Land, Castle Donington. 110 O.D.

——	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Soil and coarse gravel	12	0	12	0
Gravel and sand	10	6	22	6
Soft red marl	18	6	41	0
Stronger red marl and skerry beds	16	0	57	0

BOREHOLE No 7.—Glassly Field, Stanton. 140·23 O.D.

——	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Surface soil	1	6	1	6
Dark yellow sandstone	20	0	21	6
Lighter yellow sandstone	22	0	43	6
Soft parting	0	6	44	0
Coarse red sandstone	29	0	73	0

BOREHOLE No. 8. Stanton No. 2. 119·31, O.D.

——	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Gravel	14	0	14	0
Sandstone	26	0	40	0

BOREHOLE No. 9. Stanton No. 3. 119 O.D.

——	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Sandy soil	5	0	5	0
Gravel and sand	15	6	20	6
Light yellow sandstone	32	6	53	0
Coarse gritty sandstone	7	0	60	0
White and harder sandstone	9	6	69	6

BOREHOLE No. 10. Pumping Station, Stanton. 135·99 O.D.

——	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Surface soil (sandy)	5	0	5	0
Hard whinstone nodules [? Coarse gravel]	5	0	10	0
Rough sand (red)	4	6	14	6
Dark red sandstone	3	0	17	6
Yellow sandstone	8	0	25	6
Dark yellow sandstone	34	0	59	6
Soft dark shale	9	0	68	6
Shale with sandy bands	3	0	71	6
" "	40	6	112	0
Very hard sandstone (siliceous)	1	7	113	7
Softer sandstone	3	8	117	3
Extra hard sandstone	0	10	118	1
Slightly softer sandstone	6	2	124	3
Dark fireclay	3	7	127	10
Dark fireclay and sandstone bands	16	0	143	10
Soft dark fireclay	9	2	153	0
Hard siliceous sandstone	1	10	154	10
Light sandy fireclay	13	0	167	10
Blue and brown fireclay	18	6	186	4
Hard sandstone	1	8	188	0
Brown sandstone (water overflowed surface at 150,000 gallons per day)	4	0	192	0
Hard sandstone	2	6	194	6
Softer sandstone	4	6	199	0
Hard sandstone	3	4	202	4
Sandstone with fireclay partings	6	0	208	4
Hard sandstone	1	2	209	6
Coarse sandstone	3	0	212	6
Light clay with hard bands	6	6	219	0
Hard sandstone	0	8	219	8
Light fireclay with sandstone bands	20	4	240	0
Dark shale and thin coal bands	8	0	248	0
Dark shale and limestone bands	49	0	297	0

HATHERN. 130 O.D.

Diamond Boring commenced at 472 feet. February 3 to May 19, 1876.

From Mr. James Plant's MSS.

	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
[Older boring, details given in next section]	320	0	320	0
[No record of these strata]	153	9¼	473	9¼
Broken ground. Supposed Bunter with pebbles	3	10	477	7¼
Bunter	14	10	492	5¼
Conglomerate	8	6	–	
[Beds not described]	12	7	–	
Conglomerate	2	10	516	4¼
Blue clay with bright red lamination	2	0	–	
Dark shale with pyrites	16	1½	–	
Dark shale	39	7	–	–
Dark shale, some harder	7	11	–	–
Dark shale	20	7½	–	–
Dark shale, with hard bands	7	6	–	
Dark shale	136	3½	–	–
Dark shale, very hard, with white veins	16	0	–	–
Dark shale	8	3	–	–
Dark shale and dark and light hard rock	3	6	774	1¾
Hard rock	4	4	778	5¾
Hard light rock or Magnesian limestone	1	9	780	2¾
Dark shale and hard rock	20	3		–
Dark shale 7 ft. 7 in. with a little blue clay 2 in.	8	0		
Dark shale and hard rock	14	5		
Dark shale (lost core)	9	3	–	–
Dark shale	17	9	849	10¾
Limestone shales	14	0	–	–
Limestone shales, with a little black shale alternating	15	0	878	10¾

This section appears to be the continuation of an older boring put down in 1864-5; of which the following account is given in the *Brit. Assoc. Rep.* for 1875, p. 1.

	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
Drift	10	0	–	
Red marl	110	0	–	–
Lower Keuper Sandstone	140	0	–	–
Bunter conglomerate	60	0?	320	0

In both the above accounts of the Hathern boring the correlation of the formations and the names given to the different strata are very doubtful. This is the only account of the boring that we have been able to obtain, but as it gives some idea of the strata passed through it is worth preserving.

BOREHOLE AT THE BRICKYARD, HATHERN STATION. 135 O.D.

From Mr. George Hodson.

——	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Well	48	0	48	0
Marl	228	0	276	0
Sandstone and marl	126	0	402	0
Forest Rock	–	–	–	–

SHEEPSHED [PIPER WOOD]. Boring No. 1. About 230 O.D.

From Rev. W. H. Coleman's MSS.

——	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
Soil	1	0		
Brown marl	10	3		
Grey rock	–	3		
Brown marl	25	0		
Grey rock	2	6		
Green stone	–	6		
Brown bind	18	0	–	
Grey rock	1	6		–
Brown bind	18	6		
Grey rock	1	6	–	
Brown bind	14	0	–	–
Grey rock	1	6	–	
Brown bind	16	6	–	–
Brown rock	1	6	–	–
Brown bind	4	6	–	–
Grey rock	–	6	–	
Brown bind	12	0		
Grey rock	2	6		
Brown bind	3	6		
Grey rock	2	6		
Brown bind	7	0		
Grey rock	13	6		
Brown bind	5	0		
Grey rock	6	0		
Hard brown rock	9	0		
Hard white stone	2	0		
Brown rocky shale	12	0		
Grey rock	1	0		
Brown bind	1	6		–
Grey rock	1	6		–
Purple bind	2	0	–	–
Grey rock	1	6	–	–
Brown rock	4	4	–	–
Brown bind	4	0	–	–
Grey rock	1	6	–	–
Brown bind	10	0		–
Grey rock	1	6		–
Brown bind	4	0		
Grey rock	5	4		
Brown bind	4	2		–
Grey rock	1	6		
Brown bind	1	2		
Brown shale	6	0		
Grey rock	1	0		
Brown bind	10	0		

SHEEPSHED [PIPER WOOD]. Boring No. 1—*continued.*

——	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
Grey rock	2	6	–	–
Brown bind	1	3	–	–
Grey rock	1	6	–	–
Brown bind	2	0	–	–
Brown rock	9	3	–	
Brown bind	5	0		–
Grey rock	1	6		
Brown bind	4	5		
Brown rock	3	4		
Grey rock	3	10		–
Brown bind	5	0	–	–
Grey rock	1	6	–	–
Brown bind	5	6	–	–
Cank stone	5	0	–	–
Brown bind	1	0		–
Brown rock	6	0		
Hard brown stone	1	6		
Brown bind	5	10		
Grey stone	4	2		–
Brown bind	1	8		
Grey bind	2	0	–	–
Brown rock	5	0		
Brown stone	8	0	–	–
Grey rock	–	8	–	–
Brown bind	4	0		
Grey rock	2	9	–	–
Brown bind	1	0	–	
Grey rock	47	0	–	
Stone	6	0		
Grey rock	–	8	–	
Stone	11	0		
Grey rock	–	2		
Stone	2	9	–	–
Black smut	1	4	–	–
Stone	2	5	–	–
Grey rock	–	2	–	–
Stone	2	2	–	–
Grey rock	–	2	–	–
Stone	7	0	–	–
Grey rock	–	6	–	–
Stone	1	6	–	–
Black shale	1	3	–	–
Stone	2	0	–	–
Grey rock	–	11	–	–
Stone	4	3	–	–
Black smut	9	6	–	–
Grey rock				
Blue bind				
Grey rock				
Stone				
Grey rock				
Blue bind				
Stone				
Blue bind				
Stone				
Blue bind				
Stone				
Blue bind				
White stone				
Grey rock				
Blue stone	24	6	477	11

SHEEPSHED [PIPER WOOD]. Boring No. 2.

——	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
Soil	–	6	–	–
Clay	1	0	–	–
Marl	46	6	–	–
Brown rock	3	0	–	–
Red marl	9	0	–	
Light blue bind	1	6	–	
Grey rock	1	6		
Brown marl	12	0		
Hard white rock	3	0		
Brown shale	21	0		
Grey rock	1	0		
Brown shale	11	0	–	
Grey rock	1	6	–	–
Brown shale	30	0	–	–
Grey rock	3	0	–	–
Brown rock shale	10	6		
Grey rock	6	0	–	
Brown shale	9	0		
Brown rock	7	0		
Cank	1	0		
Brown shale	4	0		
Brown rock	30	0		–
Brown rock shale	9	0		–
Brown rock	6	0		
Brown rock shale	9	0	–	
Hard brown rock	6	0		–
Brown rock shale	9	0	–	–
Hard grey stone	–	9	–	
Brown rock shale	5	3	–	
Blue limestone [?]	6	6	246	6
Brown rock	2	6	–	–
Light blue bind	1	0	–	–
Brown rock shale	1	0	–	–
Light blue bind	1	0		–
Brown rock	6	0	–	–
Brown rock shale	15	0	–	–
Grey rock	6	0	–	–
Brown rock shale	24	0	–	–
Light blue bind	1	0	–	–
Brown bind	9	0		
Cank	4	0		
Drab rock	11	0	–	
Cank	1	0	–	–
Drab rock	9	0	–	
Light blue bind	1	6	–	–
Brown rock	9	0	–	–
Cank	6	0	–	–
Brown bind	1	6	–	–
Hard grey rock	28	1		–
Brown bind	5	4	–	–
Soft grey rock	15	1	–	–
White rock	2	6	–	–
Brown rock	1	6	–	–
White rock	3	0	–	–
Brown sandstone	1	0	–	–
Hard white rock	12	0	–	–
Brown sandstone	1	0	–	–

SHEEPSHED [PIPER WOOD]. Boring No. 2—*continued.*

——	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
Purple shale	3	6		
Gritty clay	5	10½	–	
Grey rock shale	14	7½	–	–
Dark bind	6	0	–	–
Grey rock shale	1	1	–	–
Dark bind	2	1	–	–
Hard grey rock	2	5	–	–
Dark bind	1	3	480	4
Hard grey rock	–	–	–	–

LOUGHBOROUGH, GREAT CENTRAL RAILWAY.

Sections across the valley of the Soar. From Mr. F. D. Sharpe.

No. 1. 70 chains N. of Midland Railway.

	Ft.	in.
Soil	2	6
Alluvial clay or mud	6	0
River gravel	8	0
Red marl	–	–
Total, River deposits	16	6

No. 2. Subway, 56 chains N. of Midland Railway.

	Ft.	in.
Soil	2	6
Mud like clay	6	0
River gravel	1	6
	10	0

No. 3. Accommodation bridges, 44 chains and 18 chains N. of Midland Railway.

	Ft.	in.
Soil	2	6
Mud-like clay	6	0
River gravel	1	6
	10	0

No. 4. Nottingham Road, 11 chains N. of Midland Railway.

	Ft.	in.
Mud	3	0
Gravel	5	0
Red marl	2	0
	10	0

No. 5. Bridge over the Midland Railway.

	Ft.	in.
Soil	2	6
Mud-like clay	4	0
River gravel	8	0
Marl	2	0
	16	0

No. 6. Bridge over the Canal.

	Ft.	n.
Soil	2	0
Soil and gravel	4	0
Clean gravel	6	0
Marl	—	
	12	0

No. 7. Bridge 70 chains S. of Midland Railway

Marl was reached at 10 feet below the base of the cutting which is all in gravel.

BURTON-ON-TRENT. About 150 O.D.

Messrs. Worthington & Co. Borehole 10 in. in diameter, 1891.
From Dr. H. T. Brown.

	——	Thickness.		Depth.	
		Ft.	in.	Ft.	in.
	Gravel	30	0	30	0
	Red and grey marl	30	0	60	0
	Red marl with bands of gypsum	20	0	80	0
	Indurated calcareous marl and gypsum	16	0	96	0
	Red marl (gypsum)	44	0	140	0
	Highly indurated marl	13	0	153	0
	Red marl (very gypseous)	13	0	166	0
	Hard fine-grained calcareous sandstone (mudstone)	9	0	175	0
	Grey marl	6	0	181	0
	Red marl	7	0	188	0
	Hard fine-grained micaceous sandstone, slightly calcareous	11	0	199	0
	Red marl (gypseous)	24	0	223	0
	Fine-grained hard grey calcareous sandstone	4	0	227	0
	Red marl (gypseous)	14	0	241	0
	Grey marl (gypseous)	2	0	243	0
	Red marl	21	0	264	0
	Hard marl	5	0	269	0
	Red gypseous marl	41	0	310	0
	Light red gypseous marl and sand	15	0	325	0
Water-bearing beds.	Grey marl	2	0	327	0
	Coarse sandrock (probably the great water yielding bed)	8	0	335	0
	Sandstone, finer and more coherent than the one above	14	0	349	0
	Dark red sandy laminated marl	5	0	354	0
	Dark red sandy laminated marl with more sand	12	0	366	0
	Red and grey indurated marl and gypsum with sandy bands	7	0	373	0
	Soft red sandstone	3	0	376	0
	Sandstone with marl	4	0	380	0
	Soft fine-grained sand	11	0	391	0
	Indurated red marl	14	0	405	0
	Red sandstone, similar to next but one above	30	0	435	0
	Sharp sand with very little iron staining	15	0	450	0

BURTON-ON-TRENT.

Burton Brewery Company, Artesian Well, 6th June, 1894. From a drawing by E. Timmins & Sons, Runcorn. From Dr. H. T. Brown.

——	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
Gravel	31	0	31	0
Red and grey marl	46	0	77	0
Hard marlstone and gypsum	49	0	126	0
Very hard marlstone and gypsum	37	0	163	0
Soft red marl and gypsum	16	0	179	0

Burton Brewery Company, Artesian Well—*continued.*

———	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
Hard red sandstone, and thin beds of marl *	16	0	195	0
Sandy marl *	7	0	202	0
Fine red sandstone	1	0	203	0
Marl mixed with pebbles †	14	0	217	0
Grey sandstone and pebbles of white quartz	10	0	227	0
Red plastic marl	10	0	237	0
Red gritty sandstone (much water)	15	0	252	0
Very hard grey sandstone	5	0	257	0
Red plastic marl	2	0	259	0
Light red and grey sandstone with pebbles	35	0	294	0
Red marl	1	0	295	0
Light red sandstone with pebbles	8	0	303	0
Conglomerate rock	17	0	320	0
Mixed marl	2	0	322	9
Conglomerate rock	35	0	357	0
Coarse red sandstone with pebbles	64	0	421	0
Conglomerate rock	10	0	431	0

BURTON-ON-TRENT.

Section in a trench cut in Hay, by Messrs. Worthington & Co. From Dr. H. T. Brown.

——	Thickness.	
	Ft.	in.
Mould merging into sand	–	6
Sand with roots and pulverised charcoal	1	6
Gravel of varying thickness, partly made ground	–	1
Stiff water clay with fragments of carbonaceous matter	1	7
Sand	–	5
Stiff water clay, red at the top and becoming blue and black towards the peat	2	5
Peat (6 inches to 9 inches in other places, with hazel nuts at the bottom)	–	3
Black gravel	1	6
Clean estuarine gravel below.		

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* Notes by Dr. H. T. Brown. "Only about 23 feet marked thus* which can be regarded as Lower Keuper. I have no doubt there is a fault here which cuts out about 100 feet of Lower Keuper, and brings the Upper Keuper almost in contact with the pebbly sandstones."

† "Probably fault rock. This is confirmed by Salt's boring, only 179 yards west of this. In Salt's bore there is evidence of Lower Keuper of ordinary type about 130 feet thick. It is the greater part of these beds which is missing in this bore."

BURTON-ON-TRENT.

Section in a trench in Annesley Meadow, 80 yards east of the large well of Messrs. Bass & Co. From Dr. H. T. Brown.

——	Thickness.	
	Ft.	in.
Vegetable mould	–	7
Sandy clay altering downwards to stiff clay	2	0
Stiff clay containing a good deal of peaty matter	3	16
Coarse gravel, coloured with iron and cemented	1	0
Sand about	1	0
Clean gravel below.		

BURTON-ON-TRENT.

Section 25 yards south-east of large well and 45 yards from the river.

——	Thickness.	
	Ft.	in.
Vegetable mould		6
Clay with some peaty matter changing into gravel coloured by peat	4	0
Ferruginous gravel	–	7
Sand		8

N.B.—The peaty clay seems to thicken towards the river.

BURTON-ON-TRENT.

Boring at Peter Walker & Co.'s Brewery. 151 feet above O.D.
From Dr. H. T. Brown.

——	Thickness.	
	Ft.	in
Gravel	24	0
Red marl interspersed with gypsum	6	0
Greyish marl	10	0
Nearly pure gypsum	20	0
Red marl	10	0
Grey marl with gypsum	10	0
Grey marl (no gypsum)	4	0
Grey marl with a little gypsum	6	0
Red marl	30	0
Running ground	6	0
Boring finished in hard shale.		

Supply of water 80 barrels an hour. Water rose 18 inches above the surface, afterwards stood at 8 feet 9 inches. Total solids 221 grains per gallon.

BURTON-ON-TRENT.

Boring at Dawson's Brewery, Moore Street. 150 feet above O.D.
From Dr. H. T. Brown.

——	Thickness.	
	Ft.	in.
Gravel	28	0
Red marl with a little grey marl	4	0
Red marl with gypsum and occasional thin layers of hard shale	36	0
Hard shale (Skerry)	3	0
Grey marl with a little gypsum	29	0
Red marl with a good deal of gypsum	44	0
Grey marl	6	0
Red marl with a little gypsum	20	0
Hard gritty marl	4	0
No water obtained		

BURTON-ON-TRENT.

Section in Lowe's Brickyard, Winshill. [South of the Ashby Road.] From Dr. H. T. Brown.

	——	Thickness.	
		Ft.	in.
	Vegetable soil	–	6
	Red marl about	10	0
	Thin grey calcareous sandstone, with spots of manganese	–	3
	Red marl about	5	0
A	Grey soft laminated cupriferous sandstone, very calcareous		5
	Hard massive grey sandstone		10
	Thin laminated white calcareous sandstone	–	6
	Hard massive grey sandstone	1	0
	Red gypseous marls	–	–

The bed A. 2 feet 9 inches, stands out forming a bold feature

BURTON-ON-TRENT.

Highlands Well, Winshill. About 250 O.D

Specimens taken every 10 feet by Mr. Handley. From Dr. H. T. Brown.

——	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
Brickwork (from under which runs a considerable amount of water)	30	0	30	0
Red and white sandstone	39	6	69	6
Stiff bluish white marly clay, strongly calcareous	–	6	70	0
Red and white sandstone, some micaceous and clayey	8	0	78	0
Very soft, friable, large-grained, non-calcareous, grey sandstone, with a few pebbles breaking up into coarse sand	12	0	90	0

Highlands Well, Winshill—*continued.*

Specimens at—

60 feet.	White fine-grained sandstone, slightly calcareous.
62 ,,	Laminated, indurated red marl, calcareous.
64 ,,	Micaceous red sandstone, slightly calcareous.
66 ,,	Red sandstone, soft, fine-grained, highly calcareous.
67 ,,	Bluish clay marl, highly calcareous.
68 ,,	White micaceous sandstone, soft, fine-grained, calcareous.
70 ,,	Grey sand, slightly calcareous.
72 ,,	Soft grey sandstone with a few large quartz grains, calcareous.
74 ,,	Fine grey clay, non-calcareous.
76 ,,	White sandstone, hard micaceous, somewhat calcareous.
78 ,,	Coarse friable grey sandstone with a few small pebbles.
80 ,,	
90 ,,	

Depth of well, 90 feet to the staging, 110 feet to the bottom. Bored in 1885 to a further depth of 40 feet, entirely in pebbly sandstone, with a few clay partings. At the bottom of the well is a pebbly calcareous grey sandstone similar to that seen in Dale Brook, and to that occurring between 78 and 90 feet in this well.

A fair supply of water, but not quite pure, was obtained.

BURTON-ON-TRENT.

Mr. Green's House, Winshill Road.

184 feet above O.D.

From Dr. H. T. Brown.

——	Thickness	
	Ft.	in.
Soft red marly sandstone -	16	0
Hard white sandstone	1	0
Soft red marly sandstone -	8	0
Hard red sandstone	3	0
Red marl - - -	5	0
Soft red sandstone (to water level)	7	0
	40	0

BURTON-ON-TRENT.

Mr. Forster's Well, Ashby Road, opposite Lowe's Brickyard. 290 O.D.

From Dr. H. T. Brown.

——	Thickness.	
	Ft.	in.
Soil	–	9
Soft red marl	4	0
Indurated red marl	4	9
Blue marl	–	9
Hard red argillaceous sandstone	5	0
Blue marl	–	9
Hard whitish sandstone	2	0
Highly indurated sandy red marl	21	0
	39	0

BURTON-ON-TRENT.

Sewage Works near Stretton. 140 O.D.

From Dr. H. T. Brown.

——	Thickness.	
	Ft.	in.
Soil, subsoil, and sand	3	0
Sandy clay	–	5
Red sand	1	4
Thin bed of peat	–	2
Sand stained with peat	1	0
Dark peaty clay, more peaty below	2	4
Peat with sedges and hazel nuts	1	11
Irregular bed of sand coloured by peat, with a thin, irregular bed of gravel (1 inch to 2 inches) in other places highly calcareous shell marl	1	0
Very thin beds of interstratified clay and sand	3	0
Gravel	5	0
Marl below.		
	19	2

About 30 yards west of this the gravel is 3 feet nearer the surface. The following list of shells were found in the calcareous marl:—

Amphipeplea glutinosa, *Müller* (Limnæa).
Acroloxus lacustris, *Linn* (Ancylus).
Bythinia tentaculata, *Linn.*
Limnæa stagnalis, *Linn.*
,, (Radix) auricularia, *Linn.*
,, ,, pereger, *Müller*
Physa fontinalis, *Linn.*
Planorbis (Bathyomphalus) contortus, *Linn.*
,, (Gyraulus) glaber, *Jeffreys.*
Segmentina nitida, *Müller* (Planorbis).
Valvata piscinalis, *Müller*
Cypris (small).

NEWTON SOLNEY.

Boring at Newton Park, at the upper end of the Fishponds. About 175 O.D.

From Dr. H. T. Brown.

——	Thickness.	
	Ft.	in.
Red and blue skerry	14	0
Red sandstone	3	0
Marl	13	0
White sandstone. (Water struck at base of this sandstone)	6	0
Fuller's earth and marl	4	0
Red marl	44	0
White and red sandstone with thin ironstone bands (not bottomed)	50	0
	134	0

A second supply of water at 132 feet in light-coloured sandstone. 22,924 gallons in 24 hours from two borings.

SHAFT AT WHITE HOLLOWS, TO THE SOUTH OF TICKNALL. About 375 O.D

From Rev. W. H. Coleman's MSS.

——	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
Cat clay	4	7½	4	7½
Brown bind with ironstone balls	6	0	10	7½
Blue bind	9	0	19	7½
Black bind	4	6	24	1½
Stone clunch	6	4	30	5½
Marly clunch	4	7	35	0½
Stone clunch	6	3	41	3½
Black bind	4	2	45	5½
COAL	–	6	45	11½
Dark clunch	4	6	50	5½
Black bind	4	8	55	1½
COAL	1	8	56	9½
Fireclay	4	0	60	9½
Stone clunch	4	0	64	9½
Stony bind, very strong	15	0	79	9½
White stone	12	0	91	9½
Grey stony bind	21	0	112	9½
Black stony bind	7	2½	120	0
COAL	1	10	121	10
Fireclay	7	6	129	4
Black stone with coal veins	16	6	145	10
Light-coloured stone	27	0	172	10
Open grit	3	0	175	10
Grey stony bind	12	0	187	10
Black bind with ironstone seam	5	5	193	3
Cank, or lean ironstone	–	2½	193	5½
Black bind	2	10	196	3½
Black bind with thin cank beds	–	10	197	1½
Black bind with thin ironstone beds	2	5	199	6½
Cank	–	2	199	8½
Black bind	3	3	202	11½
Cank	–	5	203	4½
Black bind	5	2	208	6½
Cank	1	0	209	6½
Black bind	6	2	215	8½
Cank	–	6	216	2½
Black bind	9	11	226	1½
Cank	–	4	226	5½
Black bind	6	5	232	10½
Cank	–	2	233	0½
Black bind	7	3	240	3½
Cank	–	5½	240	9
Black bind with two coal beds	1	6	242	3
Black bind with thin ironstone beds	5	1	247	4
Cank	–	2	247	6
Black bind	1	10	249	4
Cank	–	9½	250	1½
Black bind	4	7	254	8½
Black bind with cank beds	1	11	256	7½
Black bind with ironstone beds	1	11	258	6½
Cank	–	5	258	11½
Black bind	2	5	261	4½
Cank	–	2	261	6½
Black bind	2	7	264	1½
Black bind with two cank beds	–	9	264	10½

SHAFT AT WHITE HOLLOWS, TO THE SOUTH OF TICKNALL —*continued.*

———	Thickneess.		Depth.	
	Ft.	in.	Ft.	in.
Black bind	1	11	266	9½
Cank	–	4	267	1½
Black bind with ironstone beds	4	–	271	1½
Cank	–	8	271	9½
Black bind	2	3	274	0½
Cank	–	6	274	6½
Black bind	3	0	277	6½
Cank	–	4	277	10½
Black bind	1	7	279	5½
Cank	1	3	280	8½
Black bind				
Cank				
Black bind	1	0	281	8½
Cank	–	2	281	10½
Black bind	1	5	283	3½
Cank	–	8	283	11½
Black bind	2	3	286	2½
Cank	–	5	286	7½
Black bind	1	6	288	1½
Cank	–	2½	288	4
Black bind	1	6	289	10
Cank	–	4	290	2
Black bind	2	8	292	10
Light-coloured grit	33	6½	326	4½
Purple clay	9	9	336	1½
Tender blue bind	26	7	362	8½
COAL	–	6	363	2½
Fireclay	3	10	367	½
Clunch	8	9	375	9½
Stony bind	10	6½	386	4
Light-grey stone	15	10½	402	2½
Hard grey stone	7	2½	409	5
Dark blue bind	21	8½	431	1½
Hard grey stone	1	8½	432	10
Brown cank	–	6	433	4
Light-grey stone	24	6	457	10
Stony bind	3	11	461	9
Light-coloured stone	–	5	462	2
Light-blue bind	11	11	474	1
Ironstone	–	3	474	4
Blue bind	1	3	475	7
Dark-grey stone	14	4	489	11
Stone bind with coal sheds	15	11	505	10
Dark-blue bind	–	7	506	5
COAL	1	3	507	8
Dark sloam or fireclay		5	508	1
Dark fireclay	1	3	509	4
Light-blue bind with coal sheds	7	1	516	5
Black bind	3	4	519	9
Light-blue bind	2	3	522	0
Stone bind	12	3	534	4
Hard grey stone	2	2	536	3
Light-blue bind with coal sheds	2	11	539	5
Grey stone; bind sheds	4	0	543	4
Black bind	1	8	545	0
Hard grey stone	2	2	547	2
Dark-blue bind	10	0	557	2

SWADLINCOTE.

Well in Thompson's Brickyard, near Sharpswood Farm. 450 O.D.
From Dr. H. T. Brown.

----	Thickness.	
	Ft.	in.
Red clay	6	0
Hard breccia	8	0
Light-purple and grey bind with plants	7	0
Grey bind with ironstone and plants	4	0
Blue bind	6	0
Blue stony bind.		

CASTLE GRESLEY.

Mr. Toobey's Well, side of lane, near Castle Hill. 287 O.D.
From Dr. H. T. Brown.

----	Thickness.
Red and purple marls	4 to 5 ft
Very hard breccia	6 ,, 8 ,,
Bind to 34 ft from the top.	

CASTLE GRESLEY.

Well on west side of the road, south of the Station. About 300 O.D.
From Dr. H. T. Brown.

----	Thickness	
	Ft.	In.
Sand (Bunter)	16	0
Breccia (Permian) with hard red marl at base	30	0
Light fawn-coloured sandstone	15	0
Water found below this.		

BOREHOLE AT MESSRS. ISON'S, ASHBY-DE-LA-ZOUCH. 405 O.D.

From Messrs. Le Grand and Sutcliff.

----	Thickness.		Depth from Surface.	
	Ft.	in.	Ft.	in.
Soft sandstone	6	0	6	0
Red clay	12	0	18	0
Loamy sand	18	0	26	0
Sandstone and rock	6	0	32	0
Hard red clay	6	0	38	0
Soft sandstone	9	0	47	0
Hard red clay	23	0	70	0

PRESTOP PARK FARM, ASHBY-DE-LA-ZOUCH. Boring No. 1. 1850-1.

At the bottom of the second field S.W. of the house, not far from the brook. 391 feet above O.D.

From Rev. W. H. Coleman's MSS.

——	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
Clay and soil	1	3	1	3
Coal and smut mixed	–	6	1	9
Soft yellow clay	2	6	4	3
Blue bind	16	1	20	4
Black bat	–	9	21	1
Hard blue bind	2	10	23	11
Leathern throat (water)	–	0¾	23	11¾
Strong grey bind	2	10	26	9¾
Grey stone	4	6	31	3¾
Clunch mixed with stone	8	7	39	10¾
Grey stone	1	8	41	6¾
Strong broad blue bind	7	4	48	10¾
Strong bind	2	0	50	10¾
Strong stone	–	8	51	6¾
Strong blue bind	1	2	52	8¾
Strong stone	–	4	53	¾
Blue bind	2	6	55	6¾
Whitish stone	3	4	58	10¾
White stone	4	5	63	3¾
Light blue bind	9	11	73	2¾
Strong stone	4	3	77	5¾
Cank or ironstone	–	7	78	0¾
White stone	1	0	79	0¾
Bind as before	1	6	80	6¾
Strong stone	4	0	84	6¾
Stony bind	18	4	102	10¾
Blue bind	12	5	115	3¾
Strong bind	11	4	126	7¾
Blue bind	80	10	207	5¾
Pot or fireclay	3	0	210	5¾
Grey bind	10	0	220	5¾
Dark blue bind	1	1	221	6¾
Coal, smut	–	2	221	8¾
Grey fireclay	–	11	222	7¾
Coal, smut	–	5	223	0¾
Fire or pot-clay	1	11	224	11¾
Bind or clunch	9	1	234	0¾
Blue bind	2	9	236	9¾
Grey bind or clunch	9	7	246	4¾
Cank stone	–	6	246	10¾
Clunch	2	8	249	6¾
Cank or ironstone	3	4	252	10¾
Dark blue bind	34	6	287	4¾

PRESTOP PARK FARM, ASHBY-DE-LA-ZOUCH. Boring No. 2.

By the hedge of the first field, N.E. of the house, halfway to the Burton Road. 469 feet above O.D.

From Rev. W. H. Coleman's MSS.

———	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
Soil	3	0	3	0
Rammel	6	0	9	0
Red marl	6	6	15	6
Brick clay	3	0	18	6
Blue bind	8	6	27	0
Coal	1	1	28	1
Clunch	1	6	29	7
Blue bind	7	6	37	1
Grey stone	2	5	39	6
Blue bind	38	6	78	0
Grey stone	2	9	80	9
Blue bind with ironstone	43	3	124	0
Grey stone	2	4	126	4
Grey cank	–	10	127	2
Strong bind	43	0	170	2
Grey stone	2	10	173	0
Light bind	4	6	177	6
Cank	–	6	178	0
Soft light bind with ironstone	75	0	253	0
Dark bind	3	8	256	8
Black shale	–	2	256	10
Grey stone	9	9	266	7
Grey cank		6	267	1
Grey stone	1	3	268	4
Bind		4	268	8
Coal or smut	–	4	269	0
Fireclay	4	0	273	0
Dark bind	2	8	275	8
Fireclay	6	1	281	9
Grey stone	8	11	290	8
Dark bind	34	6	325	2
Coal	–	11	326	1
Clunch	1	0	327	1
Light bind	6	4	333	5
Coal	–	2	333	7
Clunch	–	10	334	5
Fireclay	13	0	347	5
Red marl	11	7	359	0
Red rock	19	6	378	6

TRIAL SHAFTS ON THE LEICESTER AND BURTON RAILWAY.

From Rev. W. H. Coleman's MSS.

No. 1. In the bed of the Trent at the bridge.

	Ft.	in.
Gravel and sand	3	0
Marly sandstone	–	1
Soft red marl	1	4
Hard red marl	–	1
Soft red marl	–	3
Sandstone	–	4
	5	1

TRIAL SHAFTS ON THE LEICESTER AND BURTON RAILWAY—*cont.*

No. 2. On the N. side of the road from Stapenhill.

	Ft.	in.
Marl with light blue stone	3	2
Red marl - -	4	0
Strong red marl	5	7
Gypsum - - - -	–	7
Red marl and soft thin beds of stone	4	0
Strong red marl	3	10
White stone -	–	3
Red marl softly mottled	2	1
Strong marl	1	7
Hard darkish stone - -	–	9
Red marl mottled with white	2	0
Red marl .	5	4
	33	2

No. 3. Conglomerate at Stanton Ward.

	Ft.	in.
Soil and sand with gravel	2	6
Red marl -	–	8
Sand - -	1	8
Gravel and sand	2	6
Conglomerate stone	4	0
Limestone [?]	2	4
Dark brown conglomerate	1	4
Hard conglomerate	3	0
Light grey sandy conglomerate	5	0
	23	0

No. 4. Castle Gresley Cutting. 2 chains N. of bridge.

	Ft.	in.
Soil -	1	0
Sand and gravel .	3	2
Sand - -	2	9
Sand and gravel	7	3
Sand - -	3	4
Sandstone -	4	6
	22	0

No. 5. Castle Gresley Cutting. 2 chains S. of bridge.

	Ft.	in.
Soil and gravel	2	5
Gravel and sand	3	0
Sand - - -	2	2
Dark gravel and sand	2	2
Soft sandstone - -	–	7
Light gravel and sand	2	6
Stronger gravel and sand	1	2
Sandstone	1	5
Rough gravel and sand	3	0
Small gravel and dark sand	4	8
Light gravel and loamy sand	2	3
Strong sandstone -	2	0
	27	4

No. 6. Castle Gresley Cutting. 4 chains S. of bridge.

	Ft.	in.
Soil -	1	6
Sand and gravel	2	3
Gravel	10	6
Rock	11	9
	26	0

TRIAL SHAFTS ON THE LEICESTER AND BURTON RAILWAY—*cont.*

No. 7. Castle Gresley Cutting. 6 chains S. of bridge.

	Ft.	in.
Soil	1	6
Sand and gravel	3	6
Sand	16	6
	21	6

No. 8. 14 chains N. of Swainspark tunnel.

	Ft.	in.
Soil	1	3
Yellow and blue clay	8	9
Blue bind	14	0
	24	0

No. 9. 7 chains N. of Swainspark tunnel.

	Ft.	in.
Soil	1	6
Blue and yellow clay	2	0
Stony clay	3	0
Soft blue bind	4	1
Ironstone	–	1
Blue bind	4	10
Sharp grey stone	–	1
Stony blue bind	1	4
Cank	–	5
Soft dark blue bind	2	6
Ironstone	–	1
Soft dark blue bind	7	1
Dark blue bind	6	4
Dark bind		10
Coal	–	10
	35	0

No. 10. 7 chains S. of Swainspark tunnel.

	Ft.	in.
Soil	–	6
Clay	7	0
Blue bind	3	8
Brown stone	–	2
Blue bind	2	0
Brown stone	–	4
Blue bind	1	3
Brown stone		4
Blue bind	18	6
	33	9

No. 11. 11 chains S. of Swainspark tunnel.

	Ft.	in.
Soil	–	8
Clay	5	4
Blue bind	3	0
Brown stone	–	6
Blue bind	18	0
	27	6

TRIAL SHAFTS ON THE LEICESTER AND BURTON RAILWAY—*cont.*

No. 12. 4 chains S.E. of the bridge in road from Overseal to Woodville.

	Ft.	in.
Soil	1	6
Clay	5	0
Ironstone and bind	4	0
Coal	1	6
Bind	8	0
	20	0

No. 13. 9 chains S.E. of bridge.

	Ft.	in.
Soil	–	8
Clay	2	0
Black bind	–	8
Clay	3	0
Marl	3	0
Bind	3	0
Ironstone and bind	2	8
	15	0

No. 14 Moira Station Cutting. 4 chains W. of bridge.

	Ft.	in.
Soil		10
Light sand	–	10
Rammell	1	2
Strong light blue clay	4	11
Ironstone	–	2
Dark clunch	3	0
Strong bind	2	1
Soft blue bind	–	6
	13	6

No. 15. 5 chains E. of bridge.

	Ft.	in
Soil	–	6
Sandy clay	1	0
Light clay	2	3
Coal, soft	1	8
Light clunch	2	3
Coal, soft	2	0
Dark clunch	–	8
Coal, soft	1	8
Light clunch	3	6
	15	6

No. 16. 14 chains E. of bridge.

	Ft.	in.
Soil	–	9
Rammell	1	0
Light blue clay	4	10
Coal, soft	1	2
Light stony clunch	6	4
Grey cank	–	10
Strong clunch	3	9
	18	8

TRIAL SHAFTS ON THE LEICESTER AND BURTON RAILWAY—*cont.*

No. 17. Willesley Cutting, 20 chains E. of bridge.

	Ft.	in.
Soil	–	9
Clay	3	6
Sand	3	0
Bind	12	6
Coal	1	6
Bind	16	0
	37	3

No. 18. Ashby Station Cutting.

	Ft.	in.
Soil	1	0
Clay	4	3
Marl	4	3
Clay	1	6
Soft bind	11	0
	22	0

No. 19. Prior Park Cutting. 8 chains W. of bridge.

	Ft.	in.
Soil	1	5
Sandy marl	3	5
Light sandstone	1	2
Red sandstone	2	5
Dark shale	1	0
Red sandstone	1	9
Shaly sandstone	–	–
	11	2

No. 20. On E. side of bridge.

	Ft.	in.
Soil	1	4
Hard sandstone	2	4
Red sandstone	2	4
Sandstone	3	0
Sandstone and shale	4	0
Fuller's earth	1	0
	14	0

No. 21. Breach Hill Cutting. 16 chains W. of bridge.

	Ft.	in.
Soil	1	0
Blue clay	1	8
Blue clay and sandstone	2	0
Dark brown sandstone	4	4
Hard sandstone	2	0
	11	0

No. 22. On W. side of bridge.

	Ft.	in.
Soil	1	5
Brown clay	3	7
Blue clay	3	0
Blue bind	2	6
Black bind	4	6
Fuller's earth	1	0
Black bind	12	0
	28	0

TRIAL SHAFTS ON THE LEICESTER AND BURTON RAILWAY—*cont.*

No. 23. 15 chains E. of bridge.

	Ft.	in.
Soil	2	0
Running sand	1	0
Gravel	–	6
Clay	1	0
Blue bind	10	0
Coal	2	0
Black bind	3	0
	19	6

No. 24. 32 chains E. of bridge.

	Ft.	in.
Clay	5	6
Sandstone	1	0
Red marl	1	7
Sandstone	1	2
Red bind	–	6
Coarse sandstone	3	2
Blue bind	–	6
Coarse sandstone	2	4
Red bind with stone	5	6
Hard stone	3	3
	24	6

No. 25. 45 chains E. of bridge.

	Ft.	in.
Soil	2	9
Blue clay	1	3
Wet sand	2	6
Sandstone Blue clay	6	0
	12	6

No. 26. Altons Cutting, at footpath.

	Ft.	in.
Red marl	5	6
Skerry	–	6
Red marl	3	3
Soft sandstone		10
Red marl	4	10
Sandstone	4	10
Red marl	5	5
Hard sandstone	3	0
Red marl	–	2
Hard stone	1	6
Blue clay	–	8
Stone	–	6
Red marl	–	1
Hard stone	3	0
	34	1

Trial Shafts on the Leicester and Burton Railway—*cont.*

No. 27. At next hedge but one, 14 chains further E.

	Ft.	in.
Soil	1	9
Blue clay	2	9
Red marl	1	10
Skerry	2	0
Red marl		5
Soft sandstone	–	7
Red marl	2	6
Blue marl	–	7
Soft sandstone		5
Blue marl	–	5
Hard sandstone	1	3
Red marl	5	10
Hard sandstone	1	11
	22	3

No. 28. On E. side of Altons Lane.

	Ft.	in.
Marl and soil	8	0
Soft sandstone	5	0
Red bind	3	6
Hard sandstone	–	6
Red marl	–	6
Hard sandstone	3	6
Red bind	2	0
	23	0

No. 29. Cole Orton Moor Road, on W. side of bridge.

	Ft.	in.
Clay and soil	3	7
Red marl	2	0
Soft sandstone	1	5
	7	0

No. 30. chains E. of bridge.

	Ft.	in.
Soil	1	6
Soft sandstone	2	0
Red marl	9	6
	13	0

No. 31. chains E. of bridge.

	Ft.	in.
Clay and soil	4	0
Soft sandstone	2	6
Red bind	4	6
	11	0

No. 32. chains W. of Swannington Station.

	Ft.	in.
Red clay and soil	4	0
Marl	3	0
Sandstone and skerry	3	0
Red bind	4	0
	14	0

TRIAL SHAFTS ON THE LEICESTER AND BURTON RAILWAY- *cont.*

No. 33. chains W. of Swannington Station.

	Ft.	in.
Red marl	18	0
Skerry	1	0
Red marl	14	0
	33	0

No. 34. 5 chains W. of Swannington Station.

	Ft.	in.
Soil and red clay	5	0
Blue skerry -	1	0
Red marl -	4	0
Red dice	10	0
	20	0

From Coalville to Desford there are no trial shafts as the line coincides with the old Leicester and Swannington Railway.

No. 35. 8 chains W. of road to Brickman's Hill Farm.

	Ft.	In.
Soil	–	9
Blue marl -	10	0
Clay	8	0
Red marl	2	6
	21	3

No. 36. 3 chains W. of same.

	Ft.	in.
Soil -	1	0
Marl -	7	0
Sand -	3	2
	11	2

No. 37. On W. side of the same road.

	Ft.	in.
Soil	1	0
Sandy loam	8	6
Sand -	5	0
Loamy clay	9	0
	23	6

No. 38. 2 chains E. of the same.

	Ft.	in.
Soil -	1	0
Red marl	2	0
Gravel	1	0
Sand -	2	0
Gravel	6	0
Clay -	3	0
	15	0

TRIAL SHAFTS ON THE LEICESTER AND BURTON RAILWAY—*cont.*

No. 39. Near Braunston Station on the W. side of bridge in road from Kirby Muxloe to Leicester.

	Ft.	in.
Soil	1	0
Red marl	3	0
Skerry	2	0
Marl	5	0
Skerry	2	0
	13	0

No. 40. 12 chains E. of same bridge.

	Ft.	in.
Soil	1	0
Blue clay	2	0
Red marl	5	0
	8	0

No. 41. 34 chains W. of brook from Braunston Frith.

	Ft.	in.
Soil	1	0
Red marl	14	0
	15	0

No. 42. 21 chains W. of same.

	Ft.	in.
Soil	–	10
Stone	5	4
	6	2

No. 43. 14 chains W. of same.

	Ft.	in.
Soil	1	0
Red marl	2	3
Blue marl	1	0
Stone	14	2
	18	5

No. 44. 4 chains W. of same.

	Ft.	in.
Soil	1	3
Blue clay	1	2
Stone	–	
	2	5

No. 45. 29 chains W. of bridge at two milestone in road from Leicester to Hinckley.

	Ft.	in.
Soil	1	0
Red marl	5	0
Stone	–	–
	6	0

TRIAL SHAFTS ON THE LEICESTER AND BURTON RAILWAY—*cont.*

No. 46. 20 chains W. of same.

	Ft.	in.
Soil	1	0
Red marl	11	0
	12	0

No. 47. 13 chains W. of same.

	Ft.	in.
Soil	1	0
Red marl	12	0
Stone	13	3
Stony marl	4	6
Red marl	1	0
	31	9

No. 48. 3 chains W. of same.

	Ft.	in.
Soil	1	6
Red marl	13	6
Soft stone	4	6
Clay and sand		3
Harder stone	2	0
Clay and sand	3	0
	24	9

TRENT VALLEY, SAWLEY.

Boring on north bank of River Trent, 400 yards E. of Derwent Mouth. 100 O.D.

From Mr. J. B. EVERARD.

	Ft.	in.
Soil -	5	0
Gravel -	10	0
Running sand	2	0
Yellow sand and gravel -	2	0
Grey sand and gravel	2	0
Green marl	2	6
Red marl - -	6	6
	30	0

Boring on south bank of River Trent, 300 yards E. of the footbridge over the Trent.

From Mr. J. B. EVERARD.

	Ft.	in.
Soil - - -	1	6
Sand, loamy	7	6
Black mud	3	0
Gravel, coarse	14	0
Red marl with band of green	8	0
	34	0

INDEX.

N.B.—Names of Persons (authors, observers, and informants) are in Small Capitals.

Age of the Charnwood Forest rocks, 10, 11.
Agglomerates, 6. 7, 8
Agriculture, 3, 17, 21.
Allenton, 42.
Alluvium, 3, 43, 44.
Altons Cutting, 74.
——Lane, 75.
Alvaston, 1, 41.
Anchor Church, 30.
Analysis of lime, 17.
—— Permian cement, 28.
Annesley Meadow, 61.
Anticlinal fault, 8.
—— folds, 45.
Anticline of the Coal-measures, 21.
—— Carboniferous Limestone, 13.
Area described in the memoir, 1.
Ash Spinney, 35.
Ashby-de-la-Zouch, 1, 2, 3, 4, 21, 24, 26. 30, 32, 40, 45, 48, 67, 68, 69
Ashby Cutting, 73.
Aston-on-Trent, 1, 33, 41.
Attenborough, 1, 44.
Axes of disturbance, 45.

Bardon Hill, 8. 9. 10.
Barratt, R. B., 17.
Barrow-on-Trent, 1.
———— Barrow Hill, 41.
Barrow Hill, near Osgathorpe, 18, 45.
Bass & Co., Well at, 61.
Beacon Cottage, 8.
—— Hill, 6.
Bearwood Hill, 31, 48.
Bellington Hill, 33.
Belton, 1.
Bemrose, H. H., 42.
Binns, G. J., 47.
Bitumen, 31.
Blackbrook, 9, 11, 12, 45.
—— Cottage, 8.
—— Series, 6–11.
Blackfordby, 26, 27, 47.
Bladon, 31.
Bonney & Hill, Messrs., 8, 9, 10.
Boothorpe, 28, 29, 30.
——Fault, 21, 47.
—— Pottery Works, 28.
Boring at Warren Pool, 46.
Borings, and Pit Sections, 49–73.
Borrowash, 1, 41.
Boulder-clay, 39, 40.
Boulton, 41.
Boundary Fault, 46.
Bradgate Park, 7.
Brand Series, 7.
Braunston Frith, 77.
—— Station, 77.
Breach Hill Cutting, 73.
Breaston, 1, 41, 42.
Breccia of the Permian, 24–29.
—— Trias, 32.
Breedon, 1, 3, 4, 13, 14, 15, 16, 17, 18, 20, 32, 34, 45.
—— Cloud, 4, 13, 14, 15, 16, 17, 45.
—— Fault, 45.
Bretby, 1, 4, 30.
——— Colliery, 22, 25.
——— Park, 31, 39, 40.
Brickman's Hill Farm, 76.
Brizlincote Hall, 25, 31.
Broad Hill, 9.
Brown, H. T., 18, 19, 25, 26, 28, 48, 59, 60, 61. 62, 63, 64, 67.
Browne, Montagu, 35, 42.
Buck Hill, 6, 10.
Bugley Cottage, 25.
Building-stone, 4, 17, 20, 32.
Bunter Pebble Beds, 3, 4, 30, 31.
Burleigh Wood, 7.

Burton-on-Trent, 1, 2, 3, 4. 30, 31, 33, 34, 39, 48, 59, 60, 61, 62, 63, 64.
Burton Brewery Co., 59, 60.

Cademan Wood, 7, 8.
Cadley Hill, 25.
——— Colliery, 22.
Caldwell, 31.
Califat Pit, 23.
Calke, 3, 4, 13, 17, 18, 22, 46.
Car Hill Quarry, 7.
Carboniferous Rocks, 13–23.
—— Limestone, 3, 4, 13–17.
Castle Donington, 1, 4, 19, 20, 21, 30, 31, 32, 40, 48, 52.
—— Gresley, 24, 25, 40, 67, 70.
Caulkley Wood, 25.
Cavendish Bridge Brewery, 50.
Caves in the Bunter, 30.

Chalky Boulder-clay, 39, 40.
Channels, Alteration of, 44.
—— filled with Boulder-clay, 39, 40, 47.
Charnian System, 11.
Charnwood Forest Canal, 12.
———— Farm, 9.
———— Rocks, 3, 5–12.
—— Hills, 2, 3, 4, 31, 32, 33, 34, 39, 40, 45.
Chellaston, 1, 33, 34, 39, 40.
City of Three Waters, 7, 9,
Clifton Hall, 34.
Coal-measures, 3, 21–23.
Cole Orton, 1, 3, 32.
———— Coalfield, 21, 23.
———— Colliery, 23.
———— Fault, 46, 47.
———— Hall, 39, 47.
Coleman, Rev. W. H., 18, 20, 55, 65, 68–78.
Collieries, Sections at the, 22, 23.
Convalescent Home, 10.
Copper in the Carboniferous Limestone, 17.
—— Keuper Marl, 33, 34.
Coppy Hill, 48.
Cottagers Hill, 36.
Crick, W. D., 33.
Crownend Wood, 35.
Cupriferous sandstone, 33, 34.

Dale Brook, 30.
Davidson, Dr., 14.
Dawson's Brewery, 62.
Dawson's Rocks, 4, 18, 20, 25.
Deeley, R. M., 40, 42.
Denudation of Charnwood Forest, 11.
Derby, 1, 3, 4, 34, 41.
Derwent, River, 2, 34, 39, 40, 41, 78.
Dimminsdale, 3, 13, 17, 18.
Dip of the Carboniferous Rocks, 19, 20.
—— Charnwood Forest Rocks, 7.
Diseworth, 1, 34.
Distribution of the strata, 3.
Disturbances in the Carboniferous Limestone, 13.
—— of the strata, 45–48.
Donington Park, 31, 34.
Dove, River, 2, 41, 43.
Drainage of the district, 2.
Draycott, 1, 41, 42.
Drift, 39, 40.
Drybrook Wood, 7, 8.

Eastern Coalfield, The, 23.
Economic Geology, 4, 11, 12.
Eggington, 1.
—— Common, 41, 49, 50.
Elevation of the district, 2.
———— Drift, 40.
Elvaston, 41.
Erewash River, 2, 41, 44.
—— Valley, 43.
Erratics, 39, 40.
Etwall, 1, 34, 41.
Everard, J. B., 78.

Far Park Lane, Loughborough, 40.
Faults, 45–48.
Fault, near Castle Donington, 32.
—— at King's Newton, 18.
——— Linton, 29.
——— Normanton Hills, 37.
——— Thringston, 32.
Faulting of the Charnwood Rocks, 8.
Felsites, 8, 10.
Felsitic Agglomerate, 6.
Fenney Hill, 6, 11.
—— Spring, 8.
Findern, 41, 43.
Fiord, Triassic, 11.
Flat Hill, 6.
Folding of the Charnwood Rocks, 8.
Folds of the strata, 45.
Footprints of *Labyrinthodon*, 31.
Foraminifera at Chellaston, 33.
Foremark, 30, 32.
—— Fault, 48.
—— Park, 48.
———— Farm, 20.
Forest Gate, 7.
—— Rock, 7.
Formations, Table of, 2.
Forster's Well, 63.
Fossils of the Carboniferous Limestone, 14–17.
—— from the Erewash Valley, 43.
—— from Normanton Hills, 35.
—— from the Trent Valley, 64.

Galena, 17.
Geological Formations, 2.
Glacial beds, 39, 40.
Gorsty Leys, 26.
Gotham, 1, 2, 3, 33, 35, 36, 38, 43.
Grace Dieu, 3, 7, 10, 11, 18, 31, 32, 45.
———— Warren, 7, 8.
———— Wood, 7, 8, 9.
Granophyres, 8.
Granville Colliery, 22.
Gravel, Glacial, 39.
Gravelpit Hill, 25.
Great Central Railway section, 58.

Green's Well, 63.
Gresley, 1, 2, 4, 31.
—— Wood Colliery, 22.
Greysich, 39, 40.
Griffydam, 32, 46.
Grimley's Rock, 9.
Gypsum, 33, 34.

Handley, Mr., 62.
Hanging Rocks, 7.
Hartshorn, 45.
—— Brook, 25.
Hathern, 1, 4.
—— boring, 30, 54.
—— Station boring, 55.
Hawfield Colliery, 22.
Hay, 60.
Heath End, 46.
Height of the Drift, 40.
—— —— ground, 2.
Hemington, 48.
Hermitage, 12.
High Cross Bank, 24.
—— Level Valley Gravel, 40, 41.
—— Sharpley, 5, 8, 9, 10, 11.
—— Tors, 7.
Highlands Well, 62, 63.
Hill & Bonney, Messrs., 8, 9, 10.
Hob's Hole, 7, 9.
Hodson, G., 21, 50, 51, 55.
Hoofies Wood, 25.
Hornstones, 6 7.
Horwood, A. R., 15.
Hoton, 48.
Hull, Prof., 26, 27.

Industries, 3, 11, 12.
Ingleberry Rock, 9.
Ingleby, 26, 30, 31.
—— Hill, 26.
Inlier of Carboniferous Limestone, 13.
—— Keuper Sandstone, 34.
—— Millstone Grit, 19, 20.
Intrusive character of the porphyroids, 9.
—— rocks of Charnwood, 8.
Ison's Well, 67.
Ives Head, 5, 6, 8, 10, 45.

Jamson's Plantation, 6.
Jones, J. Rupert, 33.
Judges, J. T., 44.

Kegworth, 1, 32, 33, 34, 41, 42.
Keuper Marl, 3, 4, 33, 34.
—— Sandstone, 30–33.
King's Newton, 18, 20, 45.
Kirby Muxloe, 77.
Kitchin, Dr. F. L., 14.
Kite Hill, 6.
Knowle, Hill, 26, 48.

Labyrinthodon, Footprints of, 31.
Limestone deposits, 2, 42, 43.
Landslip of Lias, 36.
Lead, 4.
Leake, 4.
Le Grand & Sutcliff, Messrs., 50, 67.
Leicester and Burton Railway Sections, 69–78.
Leicester Museum, 17.
Lias, The, 37, 38.
Lime, Analysis of, 17.
Limestone, Carboniferous, 4, 13–17.
—— Shales, 18.
Linton, 2, 29.
—— Fault, 47.
—— Heath Road, 24.
List of fossils, 14–17.
—— shells, 43, 64.
Littleover, 1, 34, 39.
Longcliff, 6, 8, 12, 40, 45.
—— Plantation, 8, 9.
Long Eaton, 1, 4, 21, 41.
———— Water Supply, 51.
—— Whatton, 1.
Loughborough, 1, 4, 12, 34, 40, 42, 44, 58.
—— Corporation Reservoir, 6, 8, 9.
—— Parks Farm, 7, 8.
Lount Pottery, 23.
—— Wood, 33, 47.
Lower Keuper Sandstone, 30-33.
—— Lias, 37, 38.
Lowe's Brickyard, Well at, 62.
Lubcloud, 6, 10, 45.
Lynam, G. T., 49, 50.

Mammalian remains, 42, 44.
Manganese, 4.
Maplewell Beds, 6, 8.
Mease, River, 2.
Measham, 47.
Melbourne, 1, 3, 4, 19, 20, 21, 24, 32, 45.
Mickleover, 1, 34, 39.
Midland Railway Sections, 32, 69–78.
Midway Houses, 25, 26, 30, 47.
Millstone Grit, 3, 4, 18–21.
Milton, 4, 18, 21, 25, 48, 50.
Minerals, 3, 4, 17.
Moira Coalfield, 21, 22.
—— Colliery, 22, 47.
—— Station, 72.
Moult Hill, 6.
Mount Pleasant, 24.

Mount St. Bernard's Abbey, 6, 8.

Nanpantan, 6, 8, 12.
Netherseal Colliery, 22, 29, 31, 47.
Newbold, 46.
Newhall, 4.
—— Fault, 47.
—— Park Colliery, 25.
Newhurst Plantation, 4, 6, 8, 9, 11.
New Swannington Colliery, 23.
Newton Solney, 1, 31, 64.
Normanton Hills, 35, 37.
—— —— Fault, 48.

Oaks, The, 5.
Old Swannington Colliery, 46.
Osgathorpe, 1, 18, 45.
Osmaston, 41.
Outwoods, 6, 7.
Overlap of the Keuper Marls, 33.
—— —— Trias, 21, 23, 45, 46.
Overseal, 24, 72.
Overthrust Fault, 8, 10.

Park Hill, 50.
PARKER, W. K., 33.
Pebble Beds, 30, 31.
Peggs Green Colliery, 23.
Peldar Tor, 8, 10.
Permian, 24–29.
Physical structure, 45–48.
Pinfold Quarries, Whitwick, 7.
Piper Wood boring, 55–58.
Pistern Hills, 2, 21, 32, 40.
Pit sections, 49–78.
PLANT, J., 54.
Pleistocene and Recent, 39–44.
Porphyroids, 7, 8, 9.
Post-Glacial Beds, 40–44.
Poxon or Pox Gravel, 25.
Pre-Cambrian Rocks, 5–12.
Prestop Park Farm, 68, 69.
Prior Park Cutting, 73.

Quarry Hill Plantation, 31.

Ratchet Hill, 8.
Recent and Pleistocene, 39–44.
REID, CLEMENT, 43.
Relationship of the Charnwood Forest Rocks, 10, 11.
Repton, 1, 31, 32, 34, 44.
—— School, 14.
—— Shrubs, 31, 39.
Reservoir Pit, 22.
Rhætic Beds, 35, 36.
Ripplemarked sandstones, 32.
Rivers of the district, 2.
River Terraces, 41, 42.
Roadstone, 4, 12.
Robin Wood, 26, 48.
Roe's Plantation, 6.
Rough, The, 6, 10.
Round Hill, 47.
—— House, 49.

Salt's boring, 60.
Sand, Glacial, 39.
Sawley, 1, 51, 78.
Sections, Well, 49–78.
Section at Allenton, 42.
—— —— Blackfordby, 27.
—— —— Boothorpe Pottery Works, 28.
—— —— Castle Donington Gas Works, 19, 20.
—— —— Castle Gresley, 25.
—— —— Grace Dieu, 19.
—— —— Linton, 29.
—— —— Normanton Hills, 37.
—— near Sharpswood Farm, 28.
—— on Sinfin Moor, 43.
—— at Wraggs Clay Works, 27.
Seven Spouts, 48.
Sewage Works, Stretton, 64.
Shafts, Sections of, 49–78.
Shakspeare, Allusion to, 44.
Shardlow, 1, 44.
SHARPE, F. D., 58.
Sharpley, 5, 8, 9, 10, 11.
Sharpswood Farm, 28, 67.
Sheepshed, 1, 4, 8, 9, 12, 55–58.
Shenton Lock, 40.
SHERBORN, C. D., 33.
Shells in alluvium, 43, 64.
SHIPMAN, J., 20.
SHRUBSOLE, O. A., 30.
Sinfin Moor, 2, 42, 43.
Sinope, 47.
—— Pit, 23.
"Skerry" sandstone, 33, 34.
Sketch at Blackbrook, 11.
—— —— Blackfordby, 27.
—— —— Castle Donington Gas Works, 19, 20.
—— —— Grace Dieu Quarry, 13.
—— —— Linton, 29.
—— —— Normanton Hills, 37.
Slate agglomerate, 7.
Smith's Gorse, 33.
Smoile Wood, 46.
—— —— Pits, 23.
Soar River, 2, 3, 4, 43, 44.
—— Valley, 30, 32, 35, 39, 41, 58.
Soil, 3, 38, 43.
South Derbyshire Coalfield, 21, 22.

Spondon, 41.
Stanford, 44.
Stanton, Old, 24, 25.
—— —— Colliery, 22.
Stanton-by-Bridge, 3, 4, 20, 21, 52, 53.
Stanton Ward, 70.
Stapenhill, 31, 70.
STAUNTON HAROLD, 18, 22, 32, 46.
Stenson, 41.
Strata, Distribution of the, 3.
—— Table of, 2.
Strawberry Hill Plantation, 6.
Streams, Principal, 2.
Stretton, 64.
Structure, 45–48.
—— of the Charnwood Forest Rocks, 7, 8.
Succession of the Charnwood Forest Rocks, 5.
Swadlincote, 1, 2, 3, 4, 21, 27, 28, 30, 47, 67.
Swainspark tunnel, 71.
Swannington, 1.
—— Colliery, 23, 46.
—— Station, 75, 76.
Swannymote Rock, 8.
Swarkeston, 1.
Swithland, 7.
Syenites, 8, 9, 10.
Syncline of the Carboniferous Rocks, 20, 45.

Table of the Charnwood Forest Rocks, 5.
—— Coal seams, 22, 23.
—— Formations, 2.
—— Fossils, 14–17, 35.
Temple Hill, 9.
Terraces, High Level, 40, 41.
—— River, 41, 42.
Thickness of the Carboniferous Rocks, 18.
—— —— Coal-measures, 22, 23.
—— —— Millstone Grit, 20.
Thompson's Brickyard, 67.
Thringston, 1, 7, 22, 31, 32, 46.
—— Fault, 18, 45, 46.
—— Mill, 46.
Thrumpton, 34.
Ticknall, 1, 3, 4, 13 14, 15, 16, 17, 18, 20, 22, 25, 26, 32, 46, 65, 66.
TIMMINS, E. & SONS, 59.
Toobey's Well, 67.
Toton Sidings, 43.
Trent, River, 2, 30, 31, 32, 33, 34, 39, 40, 41, 43, 44, 45, 48, 69, 78.
—— Bridge, 31.
—— Valley, 21, 78.
—— —— sections, 51–53.
Trias, 3, 30–36.
Triassic fiord, 11.
TUCKER, W. T., 40.
Twyford, 1.

Unconformity of the Bunter, 29.
—— at Castle Donington, 19, 20.
—— of the Keuper Marl, 33.

Valley Gravels, 40–44.
VASSALL, H., 14.

WALKER & Co., Well at, 61.
Warren Hills, 7.
—— Pool, 46.
Waterloo Clump, 39.
Water supply, 4, 21.
WELL, J. G., 28.
Well sections, 49–78.
West Leake, 1, 34, 35, 38, 40.
Western Coalfield, 22.
Weston-on-Trent, 1, 32, 41, 51, 52.
—— Cliff, 31.
White Hollows, 65, 66.
—— Horse Wood, 8.
—— House Colliery, 22.
Whittle Hill, 6.
Whitwick, 7, 8, 11, 22, 45.
Willesley Cutting, 73.
—— Park, 47.
Willington, 1.
Willis Bayley's Colliery, 23.
WILSON, E., 17.
Wilson, 20, 45
Winking Hill, 36.
Winshill, 31, 33, 34, 62, 63.
—— Fault, 48.
Woodfield Colliery, 22.
Woodville, 27, 28, 47, 72.
WOODWARD, A. S., 14.
Worthington & Co., Well at, 59, 60.
Worthington, 18, 45.
Wraggs Clay Works, 27, 28.

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